

CONFECTIONERS' RAW MATERIALS :

*THEIR SOURCES, MODES OF PREPARATION,
CHEMICAL COMPOSITION,
THE CHIEF IMPURITIES AND ADULTERATIONS,
THEIR MORE IMPORTANT USES AND
OTHER POINTS OF INTEREST.*

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PREFACE.

THE object of this volume is to supply a want that has long been felt in connection with so important a subject as "Confectioners' Raw Materials."

The only available sources at present are sundry paragraphs or perhaps a single chapter in some trade book—*e.g.*, Atkins and Cox, "The Art of Confectionery," and Jago's large treatise on the "Technology of Bread"—or trade lectures given before the members of various Students' Societies and reported in the Trade Press, or occasional notes in the various Trade Journals.

Such information, although generally accurate, is often disconnected and "bitty," rendering it somewhat difficult for the average student to follow.

An attempt is here made to give, in simple language, an account of the sources, methods of manufacture, the chemical constituents, various adulterants if any, modes of detecting such impurities, the more important uses of the materials, and in some instances the quantities required for different purposes.

To students possessing a slight knowledge of general scientific principles it is to be hoped that the book may be found both useful and reliable.

A short introduction to a knowledge of chemistry is given in the opening chapter, but it is intended in no way to displace a good but simple book on this subject, the study of which is earnestly recommended to every student of high-class confectionery. A careful perusal of the first five chapters in my "Chemistry of Breadmaking" will be found to assist the enquirer for knowledge in this particular branch of study. Towards the end of the book a chapter is contributed on the

balancing of quantities of ingredients in cake-making, as well as a few hints on the more common faults to be found in this section of the industry. References are given wherever considered necessary, but unfortunately, sources of information are scanty and not infrequently unreliable.

Nor must the reader expect to find this little book a compendium of recipes for the making of goods. It is to be hoped that the necessity for such will largely disappear with a more intimate knowledge of the theoretical and practical side of confectionery. Besides, there are already in existence a comparatively large number of books devoted almost solely to recipes.

Several years spent in close contact with some of the more able exponents of the "Art of Confectionery" have led the author to the conclusion that the less a worker studies mere recipes and devotes his or her attention to a practical knowledge of the art of balancing the various constituents for different classes of cakes, the less will he or she be liable to make mistakes. That this view of the question is accurate and logical is seen very forcibly on reading reports in the Trade Journals of debates on this very point by members of Student Societies, and, without wishing to be invidious in the matter, one cannot but admire the work done by the members of the Liverpool Society in this direction.

"The present age is an age of substitutes," and hence a considerable part of this work is taken up with accounts of the more important of those employed in each particular branch of confectioners' materials. In some cases the substitutes are more necessary than the article they displace. The chief factors regulating their use are prime cost and suitability; yet this is not so in every case. Utility must primarily be considered.

In future editions it may be advisable to add a chapter on the subject of "The theory and blending of colours," but at present a much more extended knowledge of general physics is desirable on the part of students in the higher branches of confectionery.

This little volume is intended primarily for confectioners, but cookery teachers and many others will find it both useful and instructive.

The author's thanks are due to his late son, Captain R. W. G. Grant, of the Victoria University, Manchester, for assistance in preparing diagrams to illustrate the text ; to his colleague, Miss Marion Chadwick, M.Sc.Tech., of Stockport, for kindly help in revision and proof-reading ; to Miss Eva Hibbert, of the Dyeing Department in the College, for much useful information on the colouring matters ; and to the following firms who have kindly assisted by lending blocks for several of the illustrations :- Messrs. S. Briggs and Co., Burton-on-Trent ; Messrs. Gimson and Co. (Leicester), Ltd. ; Messrs. Baird and Tatlock (London), Ltd. ; and Messrs. Adam Hilger, Ltd.

J. G.

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CONFECTIONERS' RAW MATERIALS.

CHAPTER I.

GENERAL INTRODUCTION.

ALL the more important members of the confectionery trade, in the early years of the twentieth century, should be conversant with not only all the details of the practical side of their own particular branch of the trade, but ought also to possess a general knowledge of the *raw materials* from which their goods are prepared. This entails the reading of many books of a special character, the paying of visits to many works, a keen perception to enable them to distinguish the accurate knowledge from that which is perhaps useless, and at the same time the possession of a fairly good scientific education.

Young and even middle-aged people are spending a considerable amount of their spare time in one or other of the many technical schools scattered widely throughout the country. Unfortunately, some of these students are not too well prepared for the reception of such knowledge, owing to a lack of soundness in the ordinary elementary principles of education, and thus their efforts are stultified or rendered ineffective. It is almost a necessity, if any great degree of success is to be attained, to possess a thoroughly good training in all the subjects taught in a well-equipped secondary school, such as may be found in most of our industrial towns. A knowledge of the composition of matter and the forces which act upon it and change its form are just as essential as a good grounding in drawing and modelling. In fact, the training of a first-class confectioner is as difficult a problem as that which besets a baker, brewer, or water analyst. From the foregoing statements it will be understood that the modern flour confectioner is not thoroughly equipped for his or her business unless that

person possesses not only a practical training in the work, but also a good general knowledge of some of the important arts and sciences, including chemistry, physics, botany, biology and machinery. Nor should the science of mathematics, especially calculations and geometry, be neglected, for both time and money are saved by a ready method of calculation of quantities and book-keeping; whilst geometry is the basis of decorative art.

The first-class confectioner will therefore perceive the wisdom of making a study of the outlines of most of the above-mentioned subjects, and more deeply those of chemistry and physics.

CHEMISTRY.

Chemistry is that branch of physical science which has for its chief object the study of the composition of matter. For the sake of convenience, the science of chemistry is divided into *inorganic*, *physical*, and *organic*. The former deals with the forms of matter spoken of as the *non-metals* and *metals*, including derivatives of both groups.

Organic chemistry has for its object the consideration of the *carbon compounds* and their derivatives. The same laws of combination, the same forces, and all other influences affect the compounds of both groups equally, but as there are so many thousand members of the carbon compounds it is better to treat them separately. The organic compounds form by far the largest number of the confectioner's raw materials, and practically all of them may be relegated to one or other of the many subdivisions into which this science is divided. Thus, for example, *flour* is composed mainly of starch, gluten, and water: starch belongs to the subdivision carbohydrates, as also do the sugars, dextrins, gums, and cellulose or woody-fibre—*e.g.*, the particles of bran; the gluten comes into that very complex section the proteins or nitrogenous bodies; whilst water is an inorganic substance, as also are the mineral salts or ash.

Butter and fats belong to the very important section known as the glycerides or fatty compounds.

Flavouring essences and *essential oils* form a considerable portion of the terpenes and aromatic compounds.

The chief colouring agents employed in the trade may be considered under the title of "Colour or tinctorial chemistry," another of the great subdivisions of applied organic chemistry.

All confectioners are therefore well advised to make a serious study of so important a subject as this. The title of several modern text-books dealing with organic chemistry are included in the bibliography at the end of this volume.

The frequent occurrence of a number of chemical terms in the text renders it necessary to explain a few of the more common of them.

Matter, or that of which all bodies are composed, is made up of extremely minute particles, the atoms and molecules, or better the electrons. An *atom* is usually defined to be the smallest quantity of matter that can enter into chemical combination, and rarely exists in the free state; whilst a *molecule* is composed of two or more atoms, and is the smallest quantity of matter that can exist in the free state. *Electrons* are the ultimate constituents of an atom.

Matter, under different conditions of pressure and temperature, exists in three states: gaseous, liquid, and solid. Each of these three states may be either elementary or compound matter. An *element* or elementary matter is that which is composed of one kind of matter only, as, for example, the gases, hydrogen, oxygen, nitrogen, chlorine, the liquids, bromine and mercury, the solids, sulphur, iron, copper, tin, and many others.

A *compound* or chemical compound is composed of two or more elements in a state of chemical combination, as, for example, water, which is made up of hydrogen and oxygen; sugar, a neutral solid containing carbon, hydrogen and oxygen atoms; olein, a fat or glyceride, composed also of carbon, hydrogen and oxygen atoms.

Acids.—When weak sugar solutions or weak alcoholic liquors, as, for example, sugar syrups or weak wines, are exposed to the air in a warm place for a day or two, they both readily become sour, tart or acid. Acids occur quite commonly

in foods and fruits, and cause these to possess the peculiar sour or tart flavour.

Acids are characterised by some of the following properties : A sour or acid taste resembling that of vinegar ; the power of changing the vegetable dye litmus from blue to a red shade of colour ; the neutralising of alkalis with the formation of salts and water ; and the power of dissolving some of the more common metals, as iron, zinc, lead, copper, and compounds of these and other metals.

Acids may be classified as *mineral acids*, or those that are prepared from minerals. Thus : hydrochloric (HCl) from common salt, sulphuric or vitriol (H_2SO_4) from minerals containing sulphur, nitric (HNO_3) from saltpetre or nitre, phosphoric (H_3PO_4) from phosphates and bone-ash, boric or boracic (H_3BO_3) from borax. Boracic acid and the mineral borax are very largely used in food stuffs as preservatives. Another important group of acids is the *vegetable* and *organic acids*, all of which contain carbon as an essential constituent. A knowledge of these is of considerable importance to a confectioner, as some are of great use and others harmful to the goods in his business.

The best known are those of the fatty and oxyfatty series, which include such acids as formic, acetic, butyric, myristic, oleic, palmitic, stearic, and lactic. They are said to be fatty because, when combined with the alcohol glycerin they form the natural fats ; for example, butyrim, the volatile fat of butter, is composed of butyric acid combined with glycerin ; whilst olein, the chief constituent of olive oil and most liquid fats, is composed of oleic acid and glycerin. Lactic acid is looked upon as the natural acidity of very many foods. It is also said to be the "fixed acidity" of foods and beverages, because it does not distil over with steam. Acetic acid, or the acid of vinegar, produced when any weak alcoholic beverages are exposed to the air and become sour, is said, like butyric acid, to be volatile, since both of these distil over with steam, and they also possess a marked aroma, whereas the fixed acids and fats possess scarcely any smell.

Another useful group of organic acids contains those that exist in the free state and with their potassium acid salt in many well-known fruits—hence the name of “fruit acids.” The three chief of these are *malic*—that occurs in apples and the orange-coloured berries of the mountain ash or rowans, *tartaric* and *citric*—both of which exist together in many of the common sharp or acid-tasting fruits. They are usually accompanied by their acid salt, as in the fruits of the *citrus* family—grapes, currants (*Riber*), and gooseberries. These acids and salts, when taken into the human system, are converted into alkaline carbonates, and thus tend to keep the blood alkaline.

When acids are brought into contact with alkaline hydroxides, a salt and water are formed, but if the alkali is a carbonate, as when tartaric acid is mixed with the carbonate of soda, and water is added, a salt, gas, and water are formed. The gas is carbon dioxide (CO_2), which aerates the goods, whilst the salt remains in the goods.

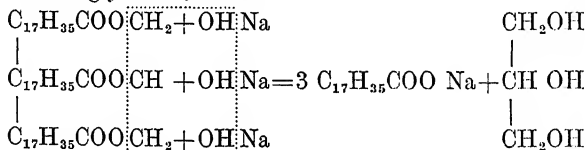
Alkalies. An alkali is the name given to substances often spoken of as bases, from the fact that most of them are the lower oxides of certain groups of metals and actually possess the properties of a base. Some of these properties are :—A soapy taste and feel ; they soften and dissolve the skin and many fibres ; they change neutral and red litmus solutions to a blue shade of colour ; they neutralise acids forming salts and water ; and dissolve such metals as zinc and aluminium, producing hydrogen gas and compounds of the metal and alkali.

Alkalies are of two kinds the caustic and mild. They include the normal and acid or hydrogen salts or bi-compounds, as they are called, of the alkaline and alkaline earths. Those of a carbonate nature, when treated with an acid, give rise to an evolution of carbon dioxide gas, in addition to forming salts and water. The chief normal carbonates are those of sodium, potassium, ammonium, lithium, calcium, and magnesium, of the general formula M^1CO_3 , as, for example, K_2CO_3 carbonate of potassium, or M^{II}CO_3 example CaCO_3 carbonate of calcium or lime. Each of the above metals yields also a

bicarbonate, example NaHCO_3 bicarbonate of soda, so largely used in the industry, and $\text{Ca} \begin{matrix} \text{HCO}_3 \\ \text{HCO}_3 \end{matrix}$ bicarbonate of calcium, a common constituent of temporary hard water, such as are found in all limestone and chalk districts.

The caustic alkalis are the hydrates or hydroxides of the same metals. They yield no carbonic acid gas when treated with acids, but possess very powerful alkaline properties; though of no use as aerating agents, yet on account of their strong detergent or scouring action they are admirable for cleansing purposes in our bakeries. These are of great importance in the manufacture of soaps—for the ordinary hard soap of commerce caustic soda is employed, and in the making of soft soap a mixture of caustic potash and soda.

Salts.—Salts are chemical compounds consisting of a base combined with an acid. The base may be a metal or any other body that can act as a base. Thus, in organic chemistry, groups of elements behaving as single elements and known as *radicles* are largely used as bases; example, the ester or ethereal ether or organic salt, ethyl butyrate; the base is the radicle "ethyl" (C_2H_5), while the acid is butyric, one of the best known volatile fatty acids. Similarly in the fats the base is the alcohol glycerol, or glycerine, combined with one or more fatty acids and known as glycerides. A soap, on the other hand, is a metallo-organic salt; example—the common hard soap of everyday life is composed of the metal or base sodium combined with the fatty acids oleic, palmitic, or stearic. The following equation represents the action of caustic soda on the glyceride, stearin:—



Stearin + Caustic Soda = Sodium stearate + glycerine.

or soap

Many other examples will readily suggest themselves to

the mind of the intelligent student, or reference may be made to a book on organic chemistry.

Organic chemistry has been defined as the chemistry of the hydrocarbons and their derivatives. Very many of these derivatives contain the elements carbon, hydrogen, and oxygen only; as, for example, the alcohols, aldehydes, ketones, acids, fats and oils (except the phosphorised fats like lecithin) and carbohydrates. Others contain nitrogen and sulphur in addition; such include the numerous groups of compounds spoken of as albuminoids, proteids, and their derivatives. Some others contain metals such as zinc, iron, arsenic, etc.

The more important elements in organic substances may be detected by the following reactions :—

Carbon and hydrogen, by mixing some of the dry substance with dry powdered copper oxide and heating the mixture in a small hard glass tube, one end of which is sealed. Note the presence of moisture on the walls of the tube; whilst, if the gases are passed into clear lime water, a turbidity of calcium carbonate is formed, indicating the presence of carbon in the original body, and the moisture points to the presence of hydrogen.

Nitrogen may be detected by heating some of the substance with soda-lime. The odour of ammonia gas indicates the presence of nitrogen. A better method is to fuse the dry substance with metallic sodium, allow to cool slightly, dissolve the residue in water, filter off any sediment, then add an acid solution of a ferrous and ferric salt; a blue colouration or even precipitate may be formed, which indicates either traces or comparatively large quantities of nitrogen in the original compound.

Sulphur may be indicated by fusing with metallic sodium, dissolving in water, filtering if necessary, and adding a solution of sodium nitro-prusside and caustic soda. A fleeting or evanescent violet colouration is formed. Or sulphur can be detected by heating with fuming nitric acid, diluting with

water, and adding barium chloride solution. A white precipitate indicates sulphur.

Phosphorus may be shown to be present by heating with strong nitric acid and adding ammonium molybdate solution. A yellow precipitate at once, or on standing, indicates the presence of phosphorus. Or the solid substance may be fused in a straw-like tube of glass with magnesium powder. On moistening with water an odour of phosphine gas is perceptible.

The above reactions are sufficient to enable the student to detect the elements present in starch, sugar, fats, whites and yolks of eggs, and in gluten or in other common organic bodies used in the bakery.

Confectioners' raw materials may be classified as:—Aerating, colouring, enriching, flavouring, shortening, sweetening, and special agents.

The chief aerating and lightening materials are yeast, those chemical compounds known as chemicals, or powders or baking powders, and well-beaten whites of eggs or egg-albumen solution containing numerous globules of entangled air.

The colouring matters include vegetable, animal, and mineral colours, and a few of the coal-tar dyes.

The most important enriching agent is eggs, or more especially the yolks.

The flavouring substances include alcoholic beverages, essences, essential oils, spices, fruits and fruit preparations, chocolate, almonds, salt, etc.

The moistening agents include water, milk, and eggs.

The shortening bodies in general use are the fats, such as butter, lard, margarines, oils, neutral or vegetable fats, and the phosphorised fat in yolks.

The sweetening materials include the sugars of different kinds, chiefly the sucroses, glucoses, inverts, and even glycerine, which also attracts moisture.

Under the title special agents may be mentioned flour, which gives body and is the base or starting point for all our goods.

In the second and succeeding chapters each of these materials will be fully considered ; the general methods of selecting ; purchasing ; their evaluation ; and the more common methods of using them to the best advantage.

Another chapter will be devoted to the usual faults found in various classes of goods, and a further chapter to the testing of the chief raw materials.

The derivation of the word confectionery is from the Latin *confectio* and *conficere*, meaning to compound, which exactly defines the confectioner's daily task.

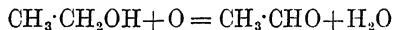


THE ALCOHOLS AND ALCOHOLIC BEVERAGES USED AS FLAVOURING MATERIALS.

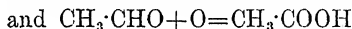
The word "alcohol" is a generic term employed to denote a large number of organic compounds that act as weak bases and yield salts spoken of as *esters*, or ethereal salts, or compound ethers, or alkyl derivatives.

They may be classified according to their behaviour towards oxidising and other reagents, or to their formulæ. Thus they are primary, secondary, or tertiary, according to their behaviour when gently oxidised.

Primary alcohols under these conditions yield first aldehydes, and when more fully oxidised, acids. Example: Spirits of wine, a primary alcohol



Ethyl Alcohol + Oxygen = Acetaldehyde + Water,

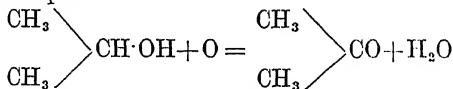


Acetic Acid.

$\text{R}\cdot\text{CH}_2\text{OH}$ is the recognised formula for a primary alcohol.

When *secondary alcohols* are similarly treated they yield a ketone; while a tertiary alcohol breaks down into simpler bodies.

Example:



Secondary Propyl Alcohol + Oxygen = Dimethyl Ketone + Water.

Secondary alcohols always contain the group $>\text{CH}\cdot\text{OH}$.

Tertiary alcohols contain the group $\geq\text{C}\cdot\text{OH}$, e.g.,



When gently oxidised they yield ketones and acids, etc. Thus, tertiary butyl alcohol yields dimethyl ketone or acetone, $\text{CH}_3\cdot\text{CO}\cdot\text{CH}_3$, acetic acid, $\text{CH}_3\cdot\text{COOH}$, carbon dioxide, CO_2 , etc., all of which are simpler bodies than the original tertiary butyl alcohol.

Alcohols are also classified according to the number of hydroxyl ($-\text{OH}$) groups contained in their composition. Thus, they are monhydric, $-\text{OH}$, dihydric $(\text{OH})_2$, trihydric or triatomic $(\text{OH})_3$, or polyhydric $(\text{OH})_n$.

The more important monhydric alcohols of use in confectionery are wood spirit or methyl alcohol, $\text{CH}_3\cdot\text{OH}$, spirits of wine or ethyl alcohol, $\text{C}_2\text{H}_5\cdot\text{OH}$, the butyl alcohols, $\text{C}_4\text{H}_9\cdot\text{OH}$, amyl alcohols, $\text{C}_5\text{H}_{11}\cdot\text{OH}$, benzyl alcohol, $\text{C}_6\text{H}_5\cdot\text{CH}_2\text{OH}$, and saligenin or salicyl alcohol, $\text{C}_6\text{H}_4\cdot\text{OH}\cdot\text{CH}_2\text{OH}$.

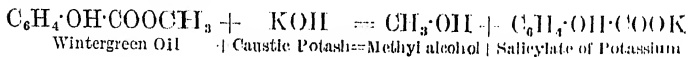
Glycerine or glycerol, $\text{C}_3\text{H}_5(\text{OH})_3$, is the only useful trihydric alcohol; it forms the base of the common fats or glycerides. It is used in the trade for the purpose of keeping cheap slab-cakes moist, owing to its power of attracting moisture from the air. The quantity is about two ounces in a seven pounds slab. It also helps to make icing soft.

The polyhydric alcohols are of importance only in consequence of their relationships to the sugars and a few other carbohydrates.

All of them, so far as is known, are white crystalline solids, soluble in water; whilst towards reagents they behave as the alcohols generally, and, like glycerine, may be both primary and secondary alcohols at the same time.

Wood Spirit or Methyl Alcohol, $\text{H}\cdot\text{CH}_2\text{OH}$.

This light volatile compound is formed by the destructive distillation of wood, hence its name, or by heating wintergreen oil, a natural essential oil occurring in the *Gaultheria procumbens* and used in the preparation of many flavouring essences, with a caustic alkali and distilling over the spirit.



When purified it is a light, colourless liquid, of burning taste ; it boils at 66° C. (151° Fah.), and has a specific gravity of 0.7963 at 60° Fah. It mixes readily with water, other alcohols and ether, and is largely used as a solvent for lacs, resins, etc., in the manufacture of varnishes, coal-tar dyes, for methylating ordinary spirits of wine to form methylated spirit, and for the preparation of certain esters and formalin, a powerful antiseptic containing about forty per cent. of the active agent, formaldehyde, $\text{H}\cdot\text{CHO}$.

Spirits of Wine or Ethyl Alcohol, $\text{CH}_3\cdot\text{CH}_2\text{OH}$.

This very important liquid is invariably manufactured by the fermentation of sugar solutions of varying strength, and prepared from almost numberless sources. Thus it gives rise to some of the greatest industries in the world, among which

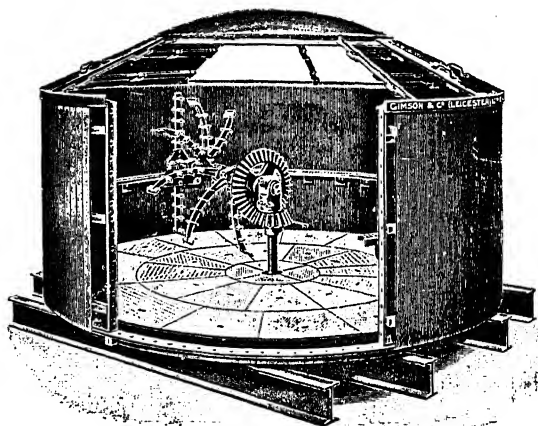


FIG. 1.—Mash-tub.

may be mentioned bread-making, brewing, distilling, the manufacture of silent or grain spirit, the production of ardent spirits, wines, cordials, and liqueurs.

The preparation of alcohol is conducted somewhat as follows :—Raw grain, as oats, rye, wheat, barley, or maize,

is cleaned, crushed between heavy rolls or circular discs, one of which has a surface similar to that of a nutmeg grater, then mixed with from nine to thirty per cent. its weight of crushed barley malt. This grist is now mixed with hot water into a kind of thin porridge at a temperature about 145° to 150° Fah. After standing for three hours the liquid is run off or expressed, and any sugars left in the grains are washed out with hot water. The malt sugar is obtained by the action of the soluble ferment, diastase or amylase, on the starch contained in the cereals of the mash.

The wort or sweet liquor, consisting of a solution of malt sugar or maltose, is cooled rapidly to 68° or 70° Fah. and filtered to take out floating particles. It runs from the filter-press into large fermenting vats, where it is thoroughly mixed with fresh strong yeast. Fermentation proceeds rapidly for some hours, and when the specific gravity of the fermented liquor or wash has dropped to nearly 1.000—that of water—the wash is freed from yeast and passed into a large patent wash-still, of the Coffey (Fig. 2) or other form, in which the alcohol is separated by the action of steam from the other products of fermentation by one distillation.

The Coffey still is composed of two metal columns, the *analyser* marked A, and the *rectifier* marked R, together with sundry accessories.

The *Wash* from the filter-press, after fermentation is over, is forced by the wash-pump P through the pipe B, the prolongation of which forms the coil CC of the rectifier.

In this coil the wash becomes heated before passing into the analyser. It is now carried by the pipe D on to the top plate of A. As it falls from plate to plate, on its way to the exit at the bottom, the wash meets with a current of steam that causes the volatile wort constituents to boil; the vapours from these pass by the pipe S at the top of the analyser into the bottom of the rectifier and up through the column, heating the coils CC on their way. The least volatile constituent, the alcohol or rectified spirit, is taken off by a pipe just below B (not shown in the diagram) whilst aldehydes and other more

volatile vapours are carried off by the upper pipe V. For a more detailed account, Thorpe's "Dictionary of Applied Chemistry," article Alcohol, may be consulted.

Such spirit is rarely of less than 84 per cent. strength, and is known as rectified, grain, or silent spirit. By another distillation it may be brought up to nearly 95 per cent. strength. This forms Cologne spirit, or the absolute alcohol of commerce. Beyond this it must be purified by chemical means, viz., by adding quick-lime, which abstracts a quantity of the remaining water; it is again distilled to free it from the slaked lime. This final product, although not quite free from water, is the British Pharmacopœia absolute alcohol.

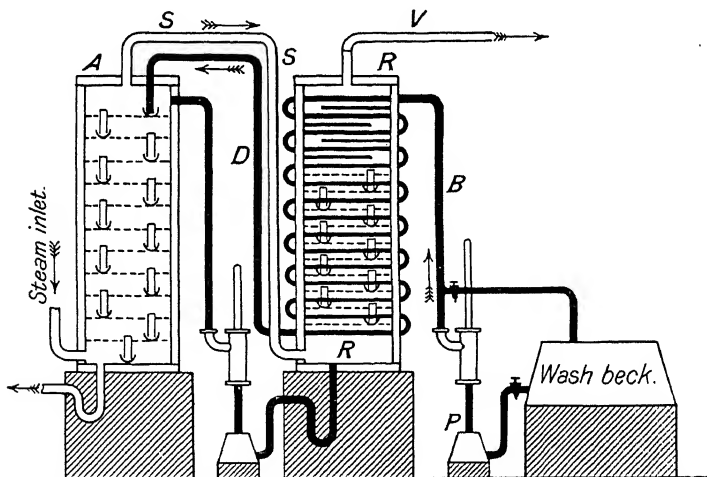


FIG. 2.—A Coffey Patent Still for spirit manufacture.

Such alcohol is a colourless, mobile spirit, possessing a pleasant, ethereal odour and burning taste. It has a specific gravity of 0.7934 at 61° Fah., boils at 172.5° Fah., and does not solidify until cooled below—267° Fah. When mixed with water a contraction in volume takes place—*e.g.*, if 100 volumes of rectified spirit are mixed with 60 volumes of water, only

156 volumes of proof spirit are obtained. Proof spirit is the name given to a mixture of alcohol and the largest quantity of water that will permit the spirit to burn.

Alcohol readily burns in air with a hot, smokeless, and almost colourless flame, hence it may be used in spirit lamps, and as a motor spirit either alone or in mixtures where a specially constructed combustion engine is employed. Another of its great uses depends on its strongly solvent properties, as for example, in dissolving gum benzoin for varnishing purposes—*e.g.*, chocolate medallions, etc. It forms the active constituent of all alcoholic beverages, cordials, liqueurs, wines, and ardent spirits.

ARDENT SPIRITS.

The use of these in confectionery is confined mainly to brandy and rum. For detailed information on ardent spirits the student is referred to the latest editions of encyclopædias like the “*Britannica*,” which may be found in most public libraries.

Brandy is prepared by the distillation of wines obtained from the grape alone, but it is also distilled from quite a variety of wines not made from grapes; it is also concocted from rectified spirit, diluted, coloured, and suitably flavoured by cœnanthic ether and other cheaper constituents.

Its value and properties depend largely on the quality of the wines from which it is distilled; thus a cheap, low quality of brandy such as is employed in the trade may be distilled from sour wines by the action of a pot-still.

In some of the French wine districts, the smaller vineyard farmers make use of a small form of a copper pot-still that travels from place to place on a cart as is required.

The ardent spirit so obtained is stored in casks in cool cellars so that it may age and mature. It is a genuine brandy, containing all the chief constituents of the spirit, and is in every way suitable for confectionery purposes, in addition to being much cheaper in price than the more costly proprietary article.

Brandy contains about 48 per cent. by weight of alcohol ; less than 1.50 per cent. of solids, and an ash (mineral salts) not exceeding 0.35 per cent ; while the sugar content must not be more than 0.40 per cent. It possesses the characteristic flavour and aroma due chiefly to the presence of cenanthic ether. The specific gravity varies between 0.9118 and 0.9384.

In one hundred thousand parts of the pure spirit are contained :—

Acidity, as acetic acid, from 48 to 130 parts ;

Esters, as acetic ether, from 65 to 150 parts ;

Higher alcohols (fusel oils), from 61 to 171 parts ;

Furfuroid compounds, from 0.28 to 3.62 parts.

Rum is that form of ardent spirit prepared by distillation, from pot or patent stills, of spirituous wash obtained by the fermentation of sugar-cane waste products. In the sugar cane industry, the crushed cane, technically known as " begasse," is extracted with water to take out the remaining sugars, dextrines, proteids and mineral salts. To this extract enough seconds or thirds molasses are added to bring up the sugar content to a strength of twelve to fifteen per cent. This wort is then fermented by a special yeast, the wash filtered and distilled.

The spirit that comes over from the still is almost colourless, and it forms the well-known white Jamaica Rum. After storage in casks for some months it darkens somewhat in colour, so as to resemble sherry in appearance. The dark ruby coloured product is merely the white rum tinted with caramel or other suitable colouring material.

Demerara rum is the name given to a faked or decocted spirit, the basis of which is grain alcohol, diluted with water to the proper strength, coloured and flavoured to match the Jamaica rum.

The genuine spirit possesses the following properties : It is a pale sherry-coloured liquid of peculiar but characteristic flavour and aroma, due chiefly to the presence of butyric and acetic esters ; the alcoholic strength varies between 25 and 51

per cent. by weight ; about 1·79 per cent. of solids ; and a specific gravity of 0·919 to 0·942.

One hundred thousand parts of the pure spirit contain :—

Acidity, as acetic acid, 28 to 179 parts ;

Esters, as acetic ether, 258 to 489 parts ;

Furfuroids, as furfural, 2·47 to 3·61 parts.

During the year 1916 the Liquor Control Board decided that rum should not be sent out of greater strength than forty under proof (40 U.P.). This means that it requires one hundred and forty parts of such rum to contain one hundred parts of proof spirit. Generally, so weak a spirit is cloudy, owing to the separation of fusel oils. This cloudiness may be removed by filtration through active animal charcoal.

Rum essence is a complex liquid of rum flavour, partly distilled and partly concocted.

WINES.

A considerable number of wines are used by the confectioner for flavouring purposes, but by far the more common are the members of the Sherry group, which includes all varieties of Sherries, Madeiras, and Marsalas. These are all fortified or brandied wines—*e.g.*, grain spirit or brandy is added to bring up the strength from eighteen to twenty-four per cent. of alcohol, thus preventing acid fermentation ; they are then placed in vessels and sent on a long sea voyage, or more frequently stored in wine cellars for two or more years so as to mature and improve.

The south-west of Spain, especially the district of Xeres—from whence the name Sherry is derived—is the chief centre of the Sherry industry ; but other countries, as Portugal, France, California, and the southern and other divisions of Australia produce Sherry wine.

A special variety of the *Vitis vinifera* produces a pale, golden-coloured grape, that when ripe is carefully gathered in the bunch, and the juices expressed from the ripened berries by means of the well-known wine-press (Fig. 3).

The juice is fermented by wine yeasts in large vats or tuns, and when the first or primary fermentation is over the new wine is transferred to storage casks, in which it gradually clarifies and comes into condition. During the latter part of

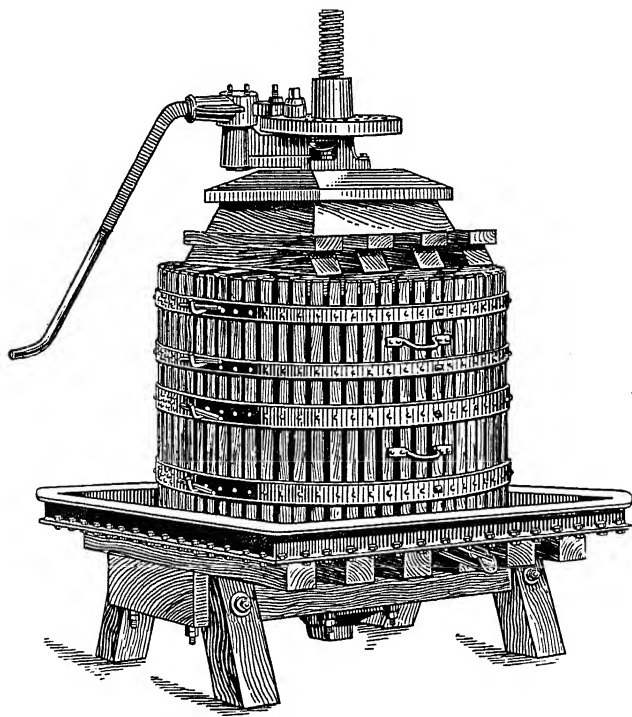


FIG. 3.—A French Wine Press.

this stage the grain or grape spirit is introduced so as to fortify and strengthen the wine. It is then bottled and subjected to further storage to enable the wine to mature.

Sherry wine possesses about sixteen to twenty-four per cent. of spirit, together with extractives, esters, and mineral

salts. The other wines previously mentioned undergo similar treatment before being placed on the market for sale.

Just as ardent spirits are faked so also are wines. Very many of the cheap Sherries and other wines used by confectioners for flavourings are innocent of the juice of the grape.

These substitutes are often sold under the name British wines, although such a term is neither suitable nor appropriate, because quite a number of wines produced in the British Isles are so excellent in quality that they are exported to certain European wine producing countries, there bottled, and sent out as famous brands of wines.

LIQUEURS AND CORDIALS.

There are very few of these costly products employed in the confectionery trade, and nearly all of them are imported from foreign sources. Those commonly used include Kirschwasser (cherry water), Maraschino, Benedictine, Curaçoa, Crème de Menthe, Crème de Noyau, etc., but mainly the three first-named.

For flavouring goods with strongly alcoholic agents, it is advisable always to use only the very best quality, otherwise there is likely to be a loss of the delicacy of flavour that the best impart. Fakes and cheap imitations invariably produce a noxious or very unpleasant after-taste when so employed.

The general principles involved in liqueur making are fairly simple: the fruits, herbs, or other raw materials are bruised and digested with suitably diluted grain spirit, or rarely, with pure spirits of wine; after sufficient steeping and extraction the volatile constituents are distilled off, the distillate sweetened with pure sugar—the quantities of sugar vary enormously from the small amount used in a dry liqueur like Kirschwasser to the large quantity that goes in the distillate for Chartreuse or Maraschino—then stored in wooden casks to mature, after which the finished article is transferred into special bottles that help to distinguish the genuine spirit. Many liqueurs are artificially coloured, either green, yellow, blue, or pink with suitable vegetable colouring matters.

Occasionally coal-tar dye stuffs are used, as for example, malachite green and azo-orange.

Kirschwasser comes from the Black Forest in Germany, and the adjoining parts of Switzerland. It is compounded from a dark coloured wild cherry, and often the kernels of other fruits; both the pulp of the fruit and contents of the stone take part in the process.

Maraschino, also a cherry product, but in this liqueur only fruit pulp is employed. In certain varieties the green leaves of cherries and raspberries are extracted with the cherry pulp. Maraschino is one of the sweetest of liqueurs.

Benedictine, one of the most famous of liqueurs, was originally prepared by the monks of the Abbey of Fêcamp in Normandy. The names of the herbs used in its decoction are unknown, but many imitations of Benedictine are on the market since the destruction of the monasteries in France.

Crème de Menthe, as its name indicates, is prepared from several varieties of mints, sage, orris root, and other herbs.

Crème de Noyau one of the few liqueurs of a reddish tint; is decocted from bitter almonds and several aromatic bodies.

ESTERS AND FLAVOURING ESSENCES.

The higher monhydric alcohols, including propyl, the butyl alcohols, the amyl group, and certain higher ones, are all employed together with the appropriate acids in the manufacture of esters or compound ethers that form the basis of many flavouring essences. These alcohols are colourless liquids possessing the usual characteristic odour and burning taste; their solubility in water decreases as their structure becomes more complex, but they are readily soluble in ordinary alcohol, ether, carbon tetrachloride, and other organic solvents; they increase in boiling point and specific gravity with increase of molecular weight.

The propyl, butyl, and amyl alcohols all occur in the products of the fermentation of sugar solutions by yeasts, and during

the process of distillation most of these are separated and collected as a dark oily liquid known as fusel oils. As before stated, they are the starting point for the preparation of esters. The more important esters used in the manufacture of fruit essences are: formic, acetic, butyric, cenanthic, sebacic, valerianic, amyl-acetic, benzoic, methyl-salicylic, and nitrous esters. A few examples will make this clear:—

Essence of pineapple consists of a mixture of a small quantity of ethyl butyrate or butyric ether in ordinary or de-odourised spirits of wine.

Jargonelle pear essence is a dilute alcoholic solution of amyl acetate or amyl-acetic ether.

Pear essence is a mixture of amyl acetate and acetic ether in a large quantity of de-odourised rectified spirit. Occasionally a small proportion of some essential oil is added.

Apple essence is generally a dilute alcoholic solution of amyl valerate or valerianic ether, with the addition of ethylacetate to modify the flavour slightly.

Strawberry essence is a mixture of formic, acetic, butyric and nitrous esters in spirits of wine.

Most of the above mentioned esters are mobile, colourless, volatile liquids of pleasant but characteristic odour and flavour, usually insoluble in water or only slightly so, and of a specific gravity lower than that of water, hence when brought into it, unless soluble, they float on its surface. The general method of preparation is to mix together the proper proportion of the necessary alcohol, the acid or an alkaline salt of it, and sulphuric acid; the mixture is digested for some time with an inverted or reflex condenser (Fig. 4), then distil over the ester at about its correct boiling point and afterwards purify by redistillation, or as necessity may require by fractional distillation.

For example, to prepare amyl acetate: Digest together in a flask fitted with a reflux condenser, two parts each of amyl alcohol and acetic acid, and one part of sulphuric acid, then distil over and purify by redistillation at 279° Fah.

Obtained in this way amyl acetate is a colourless liquid of aromatic and ethereal odour, boiling at 279° Fah., and of specific gravity 0.8841. When diluted with pure spirits of wine or grain spirit its odour resembles that of jargonelle pears. Any good book on Organic Chemistry or a Chemical dictionary may be consulted for further information on this subject, for which see the bibliography at the end of this volume.

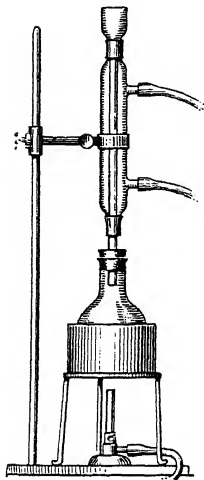


FIG. 4.—Apparatus for the preparation of many flavouring esters.

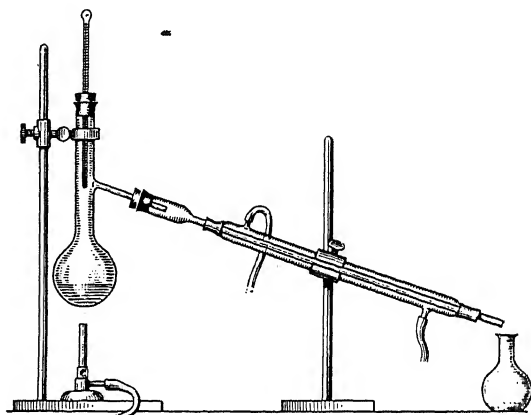


FIG. 5.—Apparatus for determining the boiling point of essential oils, essences, and other volatile liquids. Also used for distilling over volatile esters.

Glycerol, $C_3H_5(OH)_3$.

Glycerine or glycerol is the most important of the triatomic or trihydric alcohols. It occurs in the combined state as an organic salt or ester in the natural fats, whether of vegetable or animal origin.

These natural fats or glycerides are of two classes, those *volatile* in steam and which also give flavour and odour to the natural fats, as butyrim in the case of butter, and the non-volatile or *fixed* fats, that compose over 90 per cent. of the fat.

From any of its sources glycerine may be prepared by the process of saponification—*e.g.*, by heating the glycerides with some reagent, such as superheated steam, or steam and sulphuric acid, or by a caustic alkali, as in the case of soap-making. From the waste liquor of any of these processes the glycerol may be recovered, purified, and distilled to free it from water. It may also be obtained from the fermented worts of brewers and distillers.

When quite pure it is a colourless, viscid liquid of specific gravity 1.265, boiling at 554° Fah. When cooled to the freezing point of water it forms a pasty crystalline mass, that melts about the ordinary temperature of the air. It abstracts water from the atmosphere quite readily owing to its hygroscopic properties, and it is easily soluble in both water and alcohol. When strongly heated in the air it breaks up, evolving water and a gas of choking odour. This same irritating vapour is also given off whenever bodies containing glycerides, as fatty meat for example, or butter, margarine, oils, etc., are exposed to high temperatures, say about 550° Fah. In domestic cooking, a similar state of things frequently happens during the roasting of a joint of meat. This pungent gas is known as acrolëin.

Glycerol is used in the manufacture of nitro-glycerine and dynamite, as a solvent, in pharmaceutical preparations, and in the manufacture of cheap slab-cakes in order to help them to keep moist, since it possesses the power of attracting moisture from the atmosphere; also for keeping royal icing soft, and as sweetening agent in diabetic breads.

The polyhydric alcohols containing four, five, six, or more hydroxyl groups ($-OH$), are closely associated with the sugars, but beyond this they are of little interest to confectioners. It may be noted that the hexahydric alcohol, mannite or mannitol, and supposed to be the manna of the Israelites, is frequently used as a sweetmeat and also as a mild aperient for infants and young children suffering from constipation.



joint
ids.

CHAPTER III. .

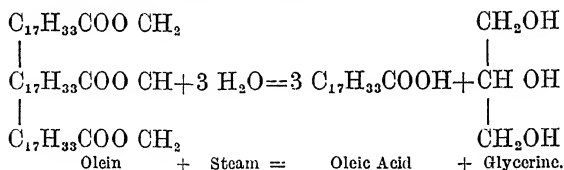
THE FATS.

The natural fats from all the different sources are mixtures of compounds, especially the glycerides. Those from animal sources are extracted by heat and pressure, but from vegetable products by pressure, or by the aid of a solvent and pressure. For example, beef suet is heated by steam and the fat in the form of an oil runs out from the fibrous cells that hold it, but the residue is subjected to the action of a filter-press to squeeze out the remaining fats. Similarly, the flead or layers of fat from pigs is cut up, the fat melted out or rendered in steam kettles, hence the term "kettle lard." All residues, however, are pressed to obtain the rest of the lard.

In the case of vegetable fatty substances, such as wheat, maize, oats, and other cereals, the germs, that contain the main portion of the oil, are treated in powerful hydraulic presses in order to express the fat, while the press-cake is broken up, treated with moisture, and again pressed. The cake is afterwards worked up into cattle food. Nuts and berries are usually ground into a meal before being placed in the hydraulic presses.

The fats or oils obtained by any of the above methods are mixtures of glycerides, of which the more common are olein, palmitin, stearin, and myristin. The olein and myristin are both liquids, palmitin a semi-pasty solid, and stearin a tough, waxy solid at the ordinary temperature. These four fats are known as "fixed fats," because they are not volatile when distilled with steam at 212° Fah. and under the normal pressure, but at considerably higher temperatures, say about

400° Fah., they are volatile in steam and at the same time broken up into glycerine and the free fatty acid or acids of which they are composed. Thus olein is hydrolysed into glycerine and oleic acid ; similarly the other fats.



A number of vegetable and some few animal fats contain *volatile fats* that are readily volatile in steam ; they also possess both flavour and smell—*e.g.*, butyrin the characteristic volatile fat of butter, which easily hydrolyses into glycerine and free butyric acid ; this latter compound causes the noxious odour in rancid butter and other fats worked up with milk, for the use of the confectioner.

The four glycerides above mentioned are common to both vegetable and animal fats ; they occur therefore in the fats used for food, such as butter, lard, tallow, nut or vegetable butter, neutral fats, chiefly cotton-seed oil preparations, those from the soya bean, palm kernels, and others. The chief point of difference between the two groups of fats is that all vegetable fats contain small quantities of the white solid alcohol, *phytosterol*, whilst animal fats contain *cholesterol*. These two substances resemble one another so closely that they may best be detected by preparing their acetates and examining the crystals by the aid of a microscope, and also by the difference in the melting points of the crystals. It is scarcely necessary to point out that the mineral oils and fats, as rock oils, paraffins, shale oils, etc., are for the most part hydrocarbons and not glycerides, therefore they will not hydrolyse into glycerine and soaps when boiled up with caustic alkalies.

Fats are used in confectionery chiefly as shortening agents, but they also assist flavour, texture, keeping properties, and general appearance in cakes. All fats employed should be of

good quality, free from rancidity, excess of salt and water, and possess good beating or air entangling qualities. Fats, especially those churned with milk, as butter and margarine, lose their delicacy of flavour and smell in a few weeks even when kept in cold stores. This accounts for the lack of fine aroma and flavour in New Zealand and other Colonial butters, that have been subjected to cold storage in the holds of ships for six or seven weeks during the voyage.

The use of antiseptics has also a baneful influence on the flavour of fats. During the last few years a new process has been devised and patented for the purification and modification of fats to be manufactured into margarine and nut butters. It consists essentially in hydrogenating—*e.g.*, treating with hydrogen gas, almost all kinds of liquid fats the chief constituent of which is olein, and thus converting the liquid into a semi-solid or solid body. The chemical explanation is that olein, which is an unsaturated compound, is converted into stearin, a fully saturated compound.

The fats—*e.g.*, whale and fish oils—are partially purified, then heated to a high temperature, mixed with a catalyst such as nickel powder or palladium black, and pure hydrogen gas passed in until the change has progressed as far as is necessary.

The chief fat-containing materials used in the trade are the various forms of milk, including whole, skimmed, separated, buttermilk, colostrum or beastings especially for custards, dried or desiccated or milk powder, cream, butter, lard, margarines and neutral fats, mainly those derived from cotton-seed, nuts, soya beans, cereal germs, linseed, and many other sources. It is now proposed to deal with a number of these useful fats in detail.

Milk.—Milk is the creamy-yellow emulsion secreted by the lacteal glands of all female mammals. As cows' milk is the one chiefly used in the trade it alone is considered in this chapter.

The milk from all mammalia contains the four proximate food principles, *viz.* : carbohydrates, fats, nitrogenous matter

or proteins, and mineral salts, all either in solution or emulsion in the water. For the young of the particular mammal the milk from its mother contains these proximate principles in the proper proportions to form a perfect food, but as the young mammal develops other foods become necessary.

There is, however, considerable variation in the composition of the milk from one group of mammals—*e.g.*, that of the cow. Amongst the chief reasons for variation may be mentioned : The state of health of the animal ; the time of milking, thus the afternoon's milk is generally richer in cream than morning's milk ; the food supplied, thus wet foods like brewer's grains whilst increasing the quantity lower the proportion of solids, especially the fat content ; the different breeds of cows cause a very great difference in the quality of the milk—*e.g.*, Channel Islands cows yielding only from 480 to 550 gallons of milk per cow per annum, but rich in fat, viz., from 4·30 to 5·10 per cent. Dutch cows give from 650 to 770 gallons, but the fat rarely exceeds 3·30 per cent. Holsteins as a rule yield approximately 800 to 1,000 gallons per annum, with a fat content below 3·0 per cent.

The following table gives the average composition of cows' milk according to Henry Droop Richmond, and also typical analyses by the author :—

<i>Constituents.</i>	(Richmond.)	(The Author.)	
		I.	II.
Water	87·30%	87·50%	86·84%
Total solids	12·70 „	12·50 „	13·16 „
Specific gravity at 60° Fah.	1032·1	1032·2	1032·0
The total solids consist of :			
Fat	3·63%	3·50%	4·04%
Solids not fat	9·07 „	9·00 „	9·12 „
These latter contain :			
Nitrogenous bodies	3·80 „	3·50 „	3·86 „
Milk sugar (lactose)	4·55 „	4·75 „	4·54 „
Mineral salts (ash)	0·72 „	0·75 „	0·72 „

For all ordinary purposes it is unnecessary to give so detailed an analysis. Generally, the amount of water, total solids, fats, solids not fat, and the specific gravity are sufficient. In England, if the solids not fat fall below 8.5 per cent. the milk is considered to contain added water, but that this is not strictly accurate is well-known to those concerned in the trade. Again, the fat content of milk varies enormously, even from the same cow. For example, the first runnings or *fore-milk* is always poor in fat, in fact it rarely exceeds 1.38 per cent., while the *afterings* or *strippings* contain up to 9.5 to 9.8 per cent. It is on this account that medical men prescribe *afterings* for consumptive patients.

It may be stated generally that milk contains over 87 per cent. of water, about 13 of solids, of which 3.6 per cent. is fat, and a specific gravity of 1032.

Confectioners frequently require to know the quantity of fat that may be obtained from one gallon of milk. The following calculation based on the previous statement will show :

1 gallon of water weighs 10 lbs., and
 1 gallon of milk, sp. gr. 1032, weighs 10.32 lbs.
 100 lbs. of milk contains 3.6 lbs. of butter-fat.

1 lb. of milk contains $\frac{3.6}{100}$ lbs. of butter-fat.

therefore 10.32 lbs. of milk contain $\frac{3.6 \times 10.32}{100}$ lbs. of butter-fat

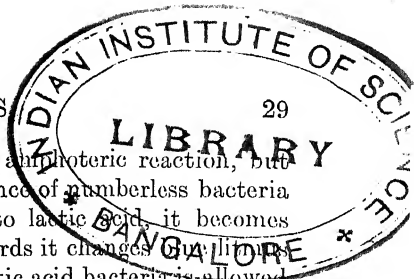
and $\frac{3.6 \times 10.32 \times 16}{100} = 5.944$ or 6 ozs. of fat.

Similarly, a milk containing 4 per cent. of fat will yield 6.605 ozs. of butter.

And a milk containing 4.8 per cent. of fat will yield 8 ozs. of butter per gallon, so that it will require in the last example two gallons of milk to give a pound of butter.

N.B.—All the above figures are based on churning results.

Milk, when freshly drawn from the cow's udder, possesses a double reaction towards test reagents, thus it is both acid



and alkaline or is said to have an amphoteric reaction, but in a few minutes owing to the presence of numberless bacteria that decompose the milk sugar into lactic acid, it becomes acid to litmus paper, or in other words it changes from litmus to red. When this action of the lactic acid bacteria is allowed to continue, as when milk is stored in a rather warm place with the temperature over 60° Fah., the quantity of acidity increases to the point at which it can coagulate or curdle the protein contents—*e.g.*, the casein chiefly; the milk is then said to be sour. Milk acidity is also partly due to the presence of acid citrates and phosphates; the quantity of these, however, is very small, probably not exceeding 0.35 per cent.

The colour of normal milk is caused by the globules of fat that it contains, and hence when the fat is removed the colour changes to a blue watery shade characteristic of skimmed or separated milk. Occasionally the colour alters owing to the action of chromogenic or colour-producing bacteria. So far as is known, blue, yellow, and pinkish-red milk may be caused by these organisms. During hot summer weather, when milk is stored in dirty vessels and kept for a lengthened period, ropy milk may be formed by the action of viscous bacteria, a disease very similar to that of ropiness in bread and caused by identical conditions. All vessels employed for storing milk must be very thoroughly cleansed with hot strong soda water, and then inverted to drain. Under no circumstances should any of the cleansed utensils either be handled on the inside or wiped out with a cloth under the pretence of drying them, as these actions introduce bacterial contamination and hasten the souring.

It is advisable that milk should if possible be kept at temperatures between 40° and 50° Fah., as milk bacteria are practically inactive at these temperatures. On the other hand, the milk must not be allowed to freeze, as its composition is changed under such conditions.

Other methods in use for preserving milk are those of Pasteurising and sterilising. When milk is heated above 158° Fah. the proteins or nitrogenous bodies are coagulated,

thus conferring a cooked flavour that to some people is highly objectionable, and also inhibiting the action of certain soluble ferments or enzymes that assist in the digestive processes.

Pasteurising is effected by heating milk either in bulk, or better, in small quantities, as in bottles, to temperatures between 143° and 155° Fah. for varying periods of time, but never for less than half-an-hour, thus enabling milk to be kept in a sweet condition for a few extra hours.

By heating milk at the boiling temperature for three successive periods of one hour, half-an-hour, and twenty minutes respectively, at intervals of approximately twenty-four hours—*i.e.*, the intermittent process—milk may be kept indefinitely.

The use of antiseptics, such as formalin, borax, boric acid, salicylic acid, fluorides, benzoic acid, or even carbonates of soda, ought on all occasions to be prohibited owing to the baneful actions of these chemicals on the digestive system.

The specific gravity of milk varies according to its quality from 1029 to 1033.5 at 60° Fah. (Water=1000.) The average specific gravity of many thousands of whole-milk samples has been shown by Henry Droop Richmond to be about 1032.1. This result may be taken as a guide in all cases by the confectioner. For the method of determining this factor see the chapter on testing and evaluating raw materials.

Cream.—Cream is the butter-fat extracted from whole milk either by skimming or the process of separation in a special centrifugal machine. By the former method the milk is allowed to stand for a considerable time, say ten to fifteen hours, in shallow wide-mouth pans in a cool place, and the cream that has risen to the surface is skimmed off. Such cream contains about 70 per cent. of water and 30 per cent. of milk solids, of which something like 20 to 25 per cent. consist of fat. The skim milk remaining from the process usually contains more than 1 per cent. of fat.

The more common method of separating the cream is by means of a centrifugal machine or whizzer of suitable construction, and known as a separator (Fig. 6). For the purpose the whole milk is passed through a sand-filter, warmed to about 120° Fah., and then passed into the separator, which separates the cream and at the same time eliminates a mass of gelatinous sludge that is full of bacteria and filth. The cream from this machine should contain over 32 per cent. of butter-fat, from 50 to 60 per cent. of water, and from 8 to 15 per cent. of solids not fat.

During the latter end of the year 1912 the Board of Trade issued a note to the effect that all cream sent out for food purposes, if it contained any thickening material such as sucrate of lime, gelatinous bodies, or other substances, and antiseptics, must be labelled otherwise than as pure cream. One-half per cent. of boracic acid, salicylic acid, or other antiseptic is permitted.

For whipping, as is often required in confectionery, pure cream is much less effective than that containing the thickening agents. The new process of cooling down the cream to about the freezing point of water with continuous stirring renders the cream useless for whipping. Already this note has had the effect of greatly increasing the use of whipped cream substitutes.

Separator milk contains from 0.1 to 0.2 per cent. of fatty bodies, and is of little use for feeding young animals. It is

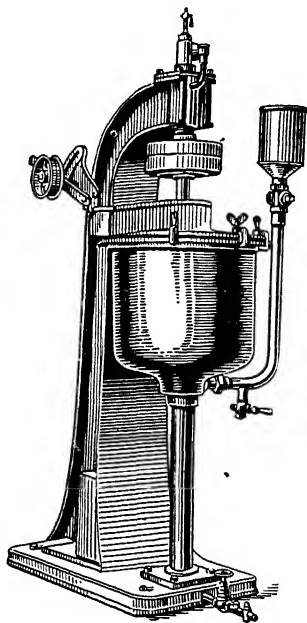


FIG. 6.—Cream Separator (centrifugal).

to a considerable extent employed in the manufacture of casein and lactose (milk sugar). The former is put to a great variety of uses, while the latter finds some use in the preparation of humanised milk, lacto-caramel, and the so-called real milk stout.

Buttermilk.—Buttermilk, the waste product obtained in the churning industry, is used up for feeding purposes and to some extent in the manufacture of scones and buns. Buttermilk gives scones a larger volume because the lactic acid present has both a chemical and physical action on the gluten of the flour, therefore in using the chemicals for aeration the quantity of the acid body should not be decreased. The chief disadvantage is that the goods on exposure to the air rapidly become dry and unsaleable.

Two varieties of buttermilk are obtainable, the more common one being that from cream that has been ripened by cultures of bacteria before being churned into butter. It possesses a pleasant acid characteristic flavour and odour; while that from unripened cream is somewhat insipid and less acid in taste.

Buttermilk is composed of approximately 90 per cent. of water and 10 per cent. of the so-called milk solids, viz., traces of fat, lactose, proteins, mineral salts or ash, and excess acidity chiefly of the lactic type. Owing to the presence of this latter body, rather less cream of tartar is required than usual. It is not at all uncommon to find that this costly acid agent is omitted altogether.

Condensed milks.—During the last few years there has been little demand in the confectionery trade for condensed milks. This is mainly due to the large quantity of milk powder of different types that has appeared on the market. Suffice it to write that condensed milks are either whole milk or skimmed milk, both sweetened and unsweetened, boiled down in vacuum pans to the consistency of malt extracts. This simile is employed because malt extract syrups are in common use amongst the trade. The chief point to be observed is that the evaporating

temperature must not be above 155° Fah. or the nitrogenous matters present in milk would become coagulated. Again, these forms of milk are not nearly so handy to a confectioner as the milk powder. Recent research goes to show that prolonged heating even below 155° coagulates the proteins of milk.

Milk powder, or dried or desiccated milk.—Several qualities of these products are now in general use. They differ from one another chiefly in the percentage of fat they contain. The whole milk or full cream dried milk is in a more or less pasty condition owing to the large quantity of fat present, which varies from 14 to 17 per cent. Moreover, this form is the least stable because the volatile glycerides, mainly butyric, readily decompose and render the milk rancid. The more common qualities are those prepared from either skimmed or even separated milk. These vary considerably in composition, as is shown in the table below :

Constituents.	Quantities.		Average Samples.	
			1.	2.
Water . .	from	7.75 to 13.68%	11.71%	12.62%
Fats . .	„	0.51 „ 16.31 „	3.35 „	4.58 „
Ash . .	„	4.78 „ 9.26 „	8.29 „	6.73 „
Proteins and Lactose }	„	59.81 „ 87.39 „	76.65 „	76.07 „

It is an interesting fact to know that the ash or mineral salts are particularly rich in phosphates. The ash in a number of samples that have been analysed in the author's laboratory have contained over 12 per cent. of this important food constituent.

Dried milk, if stored in a cool dry place, will remain good almost indefinitely. The most suitable form of it is as a granular, loose powder. It possesses the advantages of being cheap and easily made up for use for each day's requirements.

The usual method is to make a fine paste or batter with one pound of the powder in warm water and then add enough water at about 104° Fah. to make up to a gallon. It may, of course, if required, be made stronger than this.

For use in breadmaking and certain other goods the milk powder may be added in the dry state; additional water will be necessary in such cases. Several different processes are employed in reducing milk to the dry state, but the same principle is adopted in each, viz., the evaporation of the water at a temperature below the coagulating point of the nitrogenous matter.

Adulteration of Milk.—In these days of inspectors and medical officers of health the milk supply is rarely adulterated. The usual methods adopted are:

To bring milk into a vessel that contains water; or skimmed or separated milk may be mixed with fresh whole milk—this method is very frequently carried out in town areas into which the milk is brought from a long distance, with the result that in summer time milk will not keep from night until morning or from morning till evening; or some of the fat may be removed so as to save cream and bring down the milk to nearly the standard; or one or more foreign ingredients are added.

Milk may, however, fall below the recognised standard from causes other than those of adulteration. Some of these are set forth in the paragraph dealing with the causes of variation in the composition of milk. Provided that the fat is not less than 3 per cent., and the “solids not fat” are not below 8·5 per cent., milk cannot be considered adulterated. Occasionally colouring matters are mixed into the milk in order to make it appear richer than it actually is. The chief of these are of vegetable origin and harmless. Amongst them may be mentioned annatto, turmeric, marigold, carotin, saffron, safflower, and caramel. Of the solutions of coal tar dyes, members of the azo group—*e.g.*, aniline-orange and similar compounds, are most frequently used. These same colouring bodies are employed also in butter-making.

Uses of milk in confectionery.—Milk in its different forms is used largely for the following and other purposes :

In batter mixtures for the sake of cheapness ; in cakes to render the mixing cheaper ; in fermented goods to improve the flavour and make the goods eat shorter ; in cheap slabs together with nut oils and glycerine to give an even texture and assist in keeping moist ; for moistening purposes generally ; in the preparation of custards, whipped cream substitutes, etc. ; in the preparation of large numbers of foods ; while butter milk forms an essential factor in the manufacture of scones, rock, rice, and some other kinds of buns in order to obtain larger, finer-looking, and better-flavoured goods.

CHAPTER IV.

BUTTER, RENOVATED OR PROCESS BUTTER, LARD, MARGARINES, NUT BUTTERS, AND NEUTRAL FATS.

Butter.—Butter is the name given to the fatty matters obtained by the process of churning the ripened separated cream of cows' milk.

The whole milk as it comes into the dairy is tested for temperature by a thermometer and its specific gravity taken by a hydrometer. It now passes upwards through a sand-filter, and from this into the separator. This latter is a centrifugal type of machine, and if of one-and-a-half gallons capacity with five thousand revolutions per minute, will easily separate three hundred gallons of milk per hour.

The cream is heated to 155° Fah. partially to sterilise it, cooled rapidly to below 70° Fah., passed into the covered, sterile, ripening tubs, a special culture of lactic acid bacteria is well stirred in, and the cream allowed to stand until ripened. The object of this is to confer flavour and otherwise improve the butter. Sweet or unripened cream yields a mild, insipid tasting butter and buttermilk.

When ripening is complete the cream is cooled to a few degrees below 60° Fah. (Fig. 7) and churned at once. At temperatures above 60° Fah. the butter during formation occludes more water and is much less sound (not possessed of keeping properties) than butter produced below 60° Fah. A churn of two hundred gallons capacity, working at two or three revolutions per second, will form butter in about thirty to forty minutes. During the process the fat globules coalesce, partially induced in all probability by enzyme (a form of soluble ferment) action ; in factories the cream is said to break,

the resultant action being the formation of or the graining of the butter.

When the butter has formed it is removed from the churns, by wooden spatulas and well beaten to drive out the butter-milk; at the same time much care must be exercised in order to preserve the grain. It is also advisable that the butter should not be brought into contact with the human hand during these operations or it becomes contaminated with

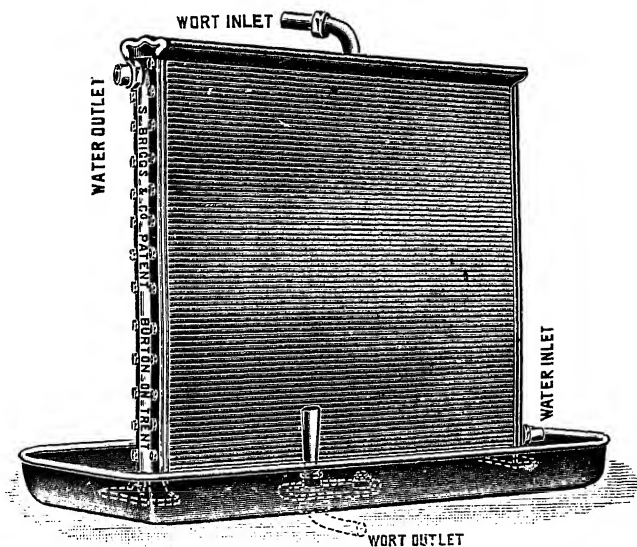


FIG. 7.—Refrigerator.

bacteria and loses its freshness and keeping qualities. Salt colouring matter, and about a half per cent. of boric acid are worked into the butter, after which it is packed into half cwt. tubs ready for the market.

Salt acts as a condiment or flavouring agent and as an antiseptic or preservative, but the quantity employed should be restricted to 2 per cent. The use of excess salt, especially coarse salt containing magnesium compounds, assists the

butter in retaining water, and thus accounts for the presence of 20 to 26 per cent. of water in certain classes of butters.

Boracic or boric acid is also an antiseptic: this body is often mixed with an equal weight of borax. The use of these preservatives ought to be restricted in all cases to a half per cent. If the proper precautions and due cleanliness were observed their use would be quite unnecessary.

Colouring materials serve only to give the fat a pleasing appearance to the eye, and hence they may be looked upon as harmless appetisers.

The chemical constituents of butter vary considerably; thus the fat may be as low as 72 and as high as 87 per cent.; water varies from 9 to 26 per cent.; salt from a half to 6 per cent.; curd or casein, milk sugar, mineral salts, and lactic acid from $1\frac{1}{2}$ to over 3 per cent.—generally these last four constituents average about 2 per cent.

The following analyses will give some idea of the actual composition of butters found in commerce:

Constituents (per cent.)	Standard Butter.	Danish.	English.	Irish.
Fats . . .	82.5	85.13	81.68	78.42
Water . . .	16.0	12.47	14.13	17.38
Curd, sugar, etc. .	1.0	1.55	2.04	1.53
Salt . . .	0.5	0.85	2.15	2.67

Siberian butter is tough, of good flavour, and well suited for making puff-paste goods.

New Zealand butter is the driest of butters, often containing no more than 9 or 10 per cent. of water, and on this account is much used for blending with butters that contain over the legal 16 per cent. of water.

Butters if stored for longer than three or four weeks lose their delicacy of flavour and smell; this accounts for the lack of flavour in many of the Colonial exports. Butter should never be melted before using, or its delicate flavour will be spoiled.

The condition of a butter may readily be ascertained by pressing out some of the water or brine it contains ; if this brine is quite clear and bright when seen in a clean glass tumbler the butter is fresh and sweet, but if cloudy or possessing an unpleasant smell decomposition has begun to take place. Again if pure butter be melted it at once becomes quite limpid, while impure butter and most margarines when melted remain cloudy for a considerable time.

Pure butter fat when separated from all the other constituents melts between 93° and 97° Fah., but commercial butter melts at temperatures varying from 104° to 113° Fah.

The uses of butter in confectionery.—If butter contains an excess of water and salt it should be thoroughly washed with pure cold water to take out the excess of salt, and then well beaten to get rid of the excess of water before being used for confectionery purposes.

It gives a better flavour, a lighter cake, and a more even texture than most other fats. The flavour depends on the presence of about $7\frac{1}{2}$ per cent. of volatile glycerides, especially butyrin. It should be employed in the making of all high-class cakes, lemon cheese curd, puff-paste goods, Genoese pastry, buttercream, pound cakes, hunting cakes, best Madeiras, simnels, slabs, layer cakes, tennis, golf, and all cakes of half-a-crown per pound and upwards in normal times ; in all fine confections, and whenever a good flavour is requisite.

For lower-class goods, mixtures of butter and margarines, or butter and neutral fats of the cottonlene and veltex types, or lard alone, may be employed ; and for the lowest-type goods mixed fats of various kinds with a little butter flavouring—a greasy-looking, yellow fluid composed of oils and flavouring esters so as slightly to resemble the flavour and odour of butter.

Lard.—The true lards are the fats obtained by rendering from the different parts of pigs. Lard substitutes are usually mixtures of prepared and bleached fats from animal and vegetable sources, or from the latter alone.

The home-rendered lard procured by cutting up flead, or the sheets of fat and tissue that line the back and certain other parts of the porcine tribe, into small cubes, and bringing these in an earthenware covered jar into a fairly cool oven until all the molten fat runs out from the divided tissues, still produces the best lard.

According to Wiley, the American lards are classified as follows :—

(1) *Neutral lard*, the best variety, pure and free from all free fatty acids, and used chiefly in the manufacture of the best margarine. This is rendered at temperatures not exceeding 110° Fah. It melts at 101° Fah.

(2) *Leaf or bladder lard*, the residue from the neutral lard, rendered by high-pressure steam, and which yields a white lard of uniform character.

(3) *Choice kettle lard*, the fat obtained in high-pressure steam kettles from all parts of the pig.

(4) *Prime steam lard*, that portion steamed and expressed from the trimmings and other parts.

(5) *Intestine or guts lard*, an inferior fat obtained from the entrails, feet, and scraps.

Like many other food fats, lard is composed chiefly of the three common glycerides, olein an oil, palmitin a semi-pasty solid, and small quantities of the hard, tough, waxy solid stearin, together with certain unsaturated compounds resembling those of linseed oil, nitrogenous compounds, mineral salts, and water.

Inferior lard—*e.g.*, intestine lard—possesses a very obnoxious fatty animal odour and flavour, hence it must be refined. Refining consists in mixing the lard with a small percentage of fullers' earth, heating, blowing gently with purified air, and filtering through a filter-press. This gives a water-clear fat that becomes snow white when cold. The blowing destroys the animal flavour while the fat is hot, and in the molten state; care is necessary not to over-blow.

When rendering lard it should not be subjected to a very high temperature or the nitrogenous compounds present

become charred and colour the fat. This colour cannot be bleached out by fullers' earth treatment, that is so commonly used with yellow fats and oils. Moreover, some of the glycerides may be decomposed, and these give the fat a bad flavour. On the other hand, if lard is rendered at too low a temperature it does not keep well, but develops an odour not unlike stale ointment. This may possibly be due to decomposition brought about by the action of enzymes or soluble ferments, or to bacteria, or both combined.

When lard has been run into the sterile vessels—whether pails, pans, bladders, casks, or the like—in which it is to be placed on the market, its surface should not be exposed to the air or touched with the hands, and it ought to be stored in cool, dry sheds or other places.

If adulterated it is usually effected by the addition of cheaper fats, such as those from the cotton-seed, soya beans, beef fat, nut oils, and fish oil preparations. Mixtures of the above fats are often sent into commerce as lard substitutes, or lard compounds.

Some of the mixtures, especially those composed of tallow—beef fat—and well refined nut oils, approach a consistency and appearance closely resembling lard. Vegetable or hogless lard or Snowdrift is made up of highly refined cotton-seed oil and small quantities of other vegetable fats.

Lard is a fat that possesses a high food value, since it is wholly absorbed and assimilated by the human alimentary system, and this makes it an important heat-producing food substance. In confectionery, owing to its greater cheapness, it partially replaces butter and even wholly replaces it as a shortening agent; it is also employed as a cooking material both for boiling and frying, and also as a greasing fat for tins and other utensils.

Lard oil is best prepared by gently melting the better qualities of lard and then allowing the liquid to cool slowly. The portions still remaining liquid are then poured off, or the whole is put through a filter-press so as to render the separation more complete. The press-cake remaining consists

chiefly of stearin, a product valuable in making pastry, margarine, and candles. Lard oil is very valuable as a food ; as a lubricant for reducing friction in machinery ; and in the manufacture of soft cake and food margarine. It should be noted that the best lard keeps better under similar conditions than badly-made butter, but it is much inferior in those qualities to the best Danish, Finnish, Siberian, and other high-class butters.

From a number of estimations made in the author's laboratories lard is shown to contain from 0·05 to 0·32 per cent. of water ; whilst its specific gravity at 104° Fah. varies between 0·889 and 0·907 ; the mineral salts from mere traces to 0·008 per cent. ; the remainder, fats of the glyceride type and occasional traces of free fatty acids and nitrogenous bodies.

Lard compounds or substitutes.—Owing to the very high prices of lards of different qualities, there are large numbers of the so-called lard compounds on the market of both English and American origin. These are intimate mixtures of low qualities of vegetable and animal fats bleached as white as possible. They possess a somewhat unpleasant fatty odour, are of a dirty-white shade of colour, are practically free from water, mineral salts, and nitrogenous matter, or in other words they consist almost entirely of fatty glycerides. With care, and in the hands of experienced workers, these substitutes for real lard give fairly good results for low grade and cheap "smalls," nor are they by any means unfitted for human consumption.

Margarines.—The chief sources of the raw materials for the manufacture of margarines are tallow, premier jus, oleo oil, cotton-seed, cocoa nut, palm kernels, soya bean, sesamé seed, arachis or pea nuts, linseed, fish roe, and other oils.

The whole of these oils must be carefully and highly refined, as they contain oils that would soon cause the margarines to become rancid, and would in some cases prove detrimental to the human system. To this group belong the cotton-seed, soya bean, and linseed oils ; in fact, soya bean oil until

thoroughly refined can be used as a substitute for linseed oil in paint and varnish making.

The oils are purified by treatment with caustic alkalies, generally caustic soda, NaOH , washed with plenty of water, dried, treated with fullers' earth, charcoal, and finally subjected to steam heating in a vacuum.

Cocoa-nut and palm-nut oils belong to quite a different class, and as a rule are wholesome natural fats, requiring very little treatment except to take out flavour and colour, then they become either snow-white or of a pale yellow colour.

Fish oils, in addition to the above mentioned special treatment, must be wholly or partly hydrogenated in order to render them innocuous and suitable for margarine manufacture. This exceptional treatment has the effect of nullifying most of the important tests on which analytical chemists relied for ascertaining the natural sources of the various fats and oils, hence it is no longer possible to discriminate with certainty between either vegetable or animal fats, including the fish oils.

Tallow is derived from fresh beef fat or suet cut from the animal whilst warm; this is cooled by immersing in ice-cold water or by placing in a refrigerator to solidify. It is next broken up into small pieces and gently heated to about 104° Fah., the liquid portions of the beef fat run out, after which the remainder is subjected to pressure to take out a further portion of the low-melting fat.

On cooling this oil, known as oleo oil, solidifies, and it forms the basis, together with the oleo oil from neutral lard, of the various margarines. There are two chief varieties in common use—the cake or soft margarine now largely employed as a substitute for butter, and the pastry or tough margarine.

These two differ mainly in the proportion of stearin that they contain; the pastry must have a higher portion of that tough, hard, waxy fat in order to give it the necessary consistency so that it may remain firm and tough under the conditions in which it is used. Cake margarine on the other hand should closely resemble butter, and be capable of being readily creamed with either sugar or flour, especially if required for the flour batter process of cake making. The methods of

manufacture differ somewhat, but the principles involved are similar in all cases. They consist in first purifying the raw fats; the blending of these in the right proportions; the churning with milk that is either fresh or Pasteurised, or even ripened, which latter permits of the introduction of more water, whereby the margarine is very liable to become rancid in warm weather or when kept in a hot bakery. Fresh whole milk gives the best results, but in no case may more than 10 per cent. of butter-fat be introduced.

The margarine is finally coloured, flavoured with butter-flavour, salted, and packed. Where the fats used are of high quality, the processes cleanly and up-to-date, the margarines themselves are good for foods and almost as digestible as butter, but they are devoid of vitamins. One of the processes in ordinary use, as seen by the author, follows this fairly closely. (See also "Margarine," by Clayton.) It is approximately as under:—

The best refined beef suet is treated as already described, and much of the tough stearin is extracted. The expressed fat is then mixed with highly refined vegetable fats of best quality. This mixture is next churned with the proper quantity of whole milk; when churning is complete the contents of the churn are run into ice-cold water, thus causing the fat to form pearly crystals, which are collected and drained. They are finally blended so as to give the well-known appearance of a high-class margarine.

Such products rarely contain more than 0·20 to 0·30 per cent. of volatile fats, while butters have over 7·0 per cent., this forming one of the chief points of difference between margarine and butter. The following table gives some idea of the chemical composition of margarines:—

Constituents (per cent.).	Le Dansk.		Others by Author.	
Fats	85·03	85·41	83·65	82·90
Water	11·75	12·47	12·18	13·35
Curd	1·72	1·59	1·61	1·64
Salt, ash, lactic acid, etc. .	1·50	0·53	2·56	2·11

Neutral Fats.—Most of these neutral fats on the market are prepared from cotton-seed oil alone, as cottolene, or are mixtures of cotton-seed oil with that of the soya bean, or other vegetable fats. Generally, they are sent out uncoloured and saltless. They contain from 97 to 99 per cent. of fat, with a little water, mineral salts, and nitrogenous matter. It is advisable therefore to use only twelve ounces of these in the place of sixteen ounces of butter.

When stored in a cool, dry place, these neutral fats remain sweet for a considerable length of time. They are very suitable for use by the flour-batter process of making cheap cakes.

Renovated or process butter.—Butter that has become rancid through the decomposition of the volatile glycerides, especially butyric, is melted in tanks of a temperature of about 112° Fah., where curd, salt, and other bodies are eliminated.

The melted fat is then air-blown and treated very similar to the method employed for refining crude fats; it is finally churned with fresh milk, and worked up as ordinary butter.

Such butter should be used at once, and never for best cakes owing to its tendency again to become rancid.

By applying a few simple tests the confectioner may readily distinguish between margarines and butter.

(1) The foam test: Bring some of the fat into an iron spoon and gently melt it over a small gas flame, then raise the temperature to the boil. Butter foams and boils gently, whereas margarines form a lump of curd and boil with bumping and a crackling noise. If the hot fat be smelled the odour of butter is very pronounced, but if the fat is margarine a tallowy smell is noticed.

(2) Melt the fat in a test tube. Notice that the butter at once becomes limpid and clear, while margarine remains cloudy for some time.

(3) If a lump of the fat about the size of a nut be brought into new milk, then warmed gently and shaken, butter blends easily with the milk, while the margarine refuses to blend.

Chemical tests are given in the chapter on the analysis of raw materials.

THE CARBOHYDRATES :

STARCH, CELLULOSE, DEXTRINES, VEGETABLE GUMS,
PECTINS, GLUCOSIDES, FLOUR.

THE name carbohydrate is given to a large number of neutral bodies that are composed of the element carbon and the elements of water ; thus, the sugar dextrose, that forms the chief constituent of glucose, is composed of six atoms of carbon, twelve of hydrogen, and six of oxygen, $C_6H_{12}O_6$, or of six atoms of carbon and six elements of water.

The carbohydrates include the starches, dextrines, gums and such allied bodies as the pectins, amylans, galactans, xylans, etc., the celluloses and the sugars. These latter are the only substances in the group that are actual foods, whilst all the others may be looked upon as potential foods or bodies that can be quite readily converted into foods by enzyme (soluble ferment) action.

Carbohydrates are widely distributed in nature, both in the vegetable and animal kingdoms, but the larger portion of those found in the latter kingdom are derived from plant sources.

According to the great botanist, Sachs, the carbon dioxide, CO_2 , of the atmosphere together with moisture, warmth, sunlight, and chlorophyll granules, together constitute the raw materials that plants employ to form the many carbohydrates of which they are mainly constructed. Thus, cellulose or woody fibre that forms the chief bulk of a tree, or the stem of cereals like wheat, or of a sugar cane, is a carbohydrate in an impure form, composed of 44.44 parts by weight of the element

carbon, and 55.56 parts by weight of water in a hundred of cellulose $(C_{12}H_{20}O_{10})_n$.

Many theories have been propounded in order to explain the formation of carbohydrates in nature, but so far none of them are capable of explaining all the known facts and are therefore unsatisfactory. Thus, according to Balls, the theory of Sachs is incorrect because the carbon dioxide of the atmosphere is insufficient for plant requirements, and it is probable that the rootlets take up carbon in the form of bicarbonates—*e.g.*, bicarbonate of potassium, $KHCO_3$, that exists in most soils. When once formed these bodies (carbohydrates) are used in building up the cellulose structure of the plant, whilst other portions are stored up in the seeds, as for example the starch in the wheat berry and other cereals, in tubers as in potatoes, cassava tubers, in which starch is the all important factor as a reserve food supply for the young plant.

Many other interesting theories might be quoted, but enough have been set forth to show that the subject is not exhausted or even fully explained. Students are advised to study such works as those of Sachs, Sowerby, Strasburger, and Vines for further information on botanical subjects.

For the sake of simplicity, the study of the carbohydrates may be divided into the following: the polyoses or polysaccharides, the simple sugars, and the higher ones. The polyoses include all those bodies that have been referred to as potential foods, *viz.*, the starches, dextrines, gums, pectins, and celluloses.

Starch or Amylum $(C_{12}H_{20}O_{10})_n$.

Starches exist widely distributed through the vegetable kingdom in almost all parts of the plant, but is specially manufactured in the leaves and stored as a reserve food supply for the young plant; thus in the members of the order of the *gramineæ*, or grain producers, the seed or caryopsis contains the starch, while in other plants such as the dahlia, potato, and cassava, it is found in quantity in the underground tubers.

From all these sources it may be extracted by suitable processes. The following is one of several employed in obtaining starch from maize or Indian corn, wheat, and other cereals :—

The grain is first cleaned by special machinery to free it from all foreign bodies, and is then steeped in warm water contained in metal or wooden troughs for about three days or until sufficiently soft. Usually the water contains a small quantity of sulphurous acid to prevent putrefaction and acid fermentation by bacteria and other micro-organisms. It is next drained and passed through a pair of burr stones, similar to those used for grinding cereals into meal, or through steel rollers, one pair coarse and the other fine. The crushed grain is at once transferred to a tank filled with water and fitted with wooden stirring gear.

Here the germs and some portions of the husky matter float to the surface and are collected, washed, and dried for further treatment. The starchy mass is again finely ground with water, passed on to a fine screen or sieve known as a "shaker." The starch liquors run through into settling tanks; the separated starch is washed with various reagents, as acids and alkalies, to free it from undesirable impurities, then washed with water to get rid of traces of the purifying agents, and allowed to settle to the bottoms of the tanks (its specific gravity compared with water is about 1.58 to 1.64). The wet starch is first partially dried by centrifugals, and finally by steam pipes or hot air.

The waste products are all worked up and sent on to the market. Oil from the germs is extracted by pressure, refined, and used for mixing with olive oil to form a cheap salad oil; in the manufacture of margarine or of nut-butters; and the coarser portions for soap-making. The press-cake, branny particles, nitrogenous matter and other waste bodies are converted into cattle cake.

Generally a bushel of corn weighing from fifty-six to sixty pounds yields from twenty-eight to thirty pounds of finished starch.

An example of the composition of wheat and the starch obtained from it is given below :

Constituents (per cent.).	Wheat.	Starch.
Starch	67·85	89·13
Cellulose and sugars	2·44	traces
Proteins	12·47	0·48
Fats	2·35	traces
Mineral salts	1·66	0·14
Water	13·23	10·25
	<hr/> 100·00	<hr/> 100·00

The chemical properties of starch.—Starch is a white lustrous powder, and with the exception of potato-starch is devoid of smell. It is quite insoluble in cold water, spirits of wine, ether, chloroform, and the other usual solvents.

When dried in the air it contains from 16 to 18 per cent. of moisture ; if heated to 215° Fah. for several hours it loses the whole of its moisture and becomes very hygroscopic, so that if left in a damp store it may re-absorb over 30 per cent. of water from the atmosphere. When quite dry it can be heated to 300° Fah. without being changed, but if any moisture is present it begins to decompose, and if the heating be progressive it loses water of combination and the starch molecule breaks down, yielding white, yellow, yellowish-brown or brown starch gums or British gums, according to the temperature. These gums are largely used in the finishing of cotton goods. The changes taking place also give a clue as to what is happening during the baking of various confectionery goods. The starch-gums contain reducing sugars, dextrines, proteins, and traces of mineral salts.

When starch is boiled with water the interior powder or granulose absorbs water, swells, and bursts the outer covering of farinose, forming starch paste or gelatinised starch such as is used in the laundry. Granulose is probably a mixture of

amylose and amylopectin. Similarly, during the baking of the goods, the starch in the dough is gelatinised, dried and converted into an edible form.

If some saliva is thoroughly mixed with warm starch paste, the latter becomes quite liquid and clear, and in a short time possesses a sweet taste. This is because the enzymes or soluble ferments of the saliva have hydrolysed the starch-paste into dextrines and malt sugar; so also when starch-paste is treated with either malt flour or diastase paste, or when the starch paste is boiled for a few minutes with dilute acid. Such a process is said to be one of hydrolysis, for the starch is enabled to take up molecules of water and gradually break down its complex molecule into much simpler ones—*e.g.*, maltose and dextrines. The actual size, however, of the starch molecule still remains an unknown factor. Brown and Morris, in their researches on starch transformations, showed that even a molecule of soluble starch contained 5,280 atoms, but were quite unable to determine the size of the molecule of ordinary granular starch.

Cold starch paste gives a blue coloration with a solution of iodine, but after the treatment described above it loses this property as it is no longer starch; but if boiled for a few minutes with Fehling's solution—alkaline copper tartrate—it gives a red precipitate of cuprous oxide, Cu_2O , which is not obtained by boiling starch paste with the reagent.

If the thin brown crusts on baked doughs are extracted with water, and the aqueous extract is boiled with Fehling's solution, a similar red precipitate is formed, because the slight acidity present, together with the heat of the oven, have converted the starch of the flour, used for making the dough, into the reducing sugar maltose and dextrines.

Starch paste does not form a true solution, as do sugar, salt, nitre, and many other salts, owing to the colloidal nature of its large-sized, gelatinous, molecule; nor can such a solution be filtered. According to the latest theories, starch is composed of variable mixtures of amylose, amylopectin and amylocellulose.

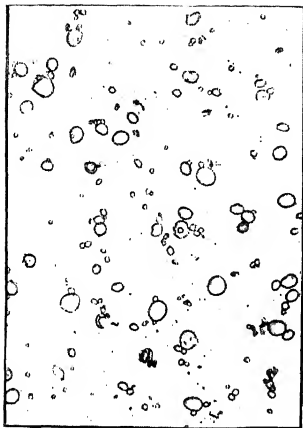


Fig. 8.

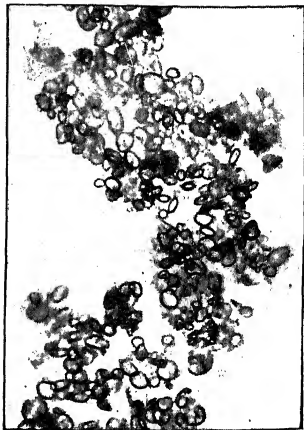


Fig. 9.

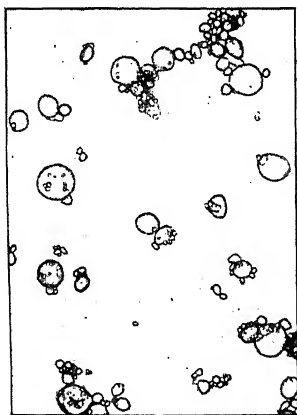


Fig. 10.



Fig. 11.

STARCHES. (Magnification $\times 120$ diams.)

8. Wheat.

9. Barley.

10. Rye.

11. Rice

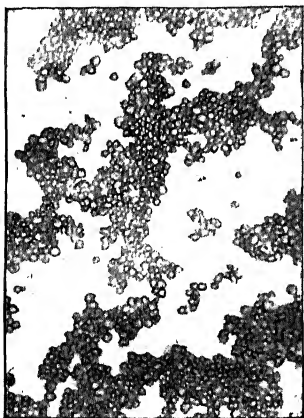


Fig. 12.

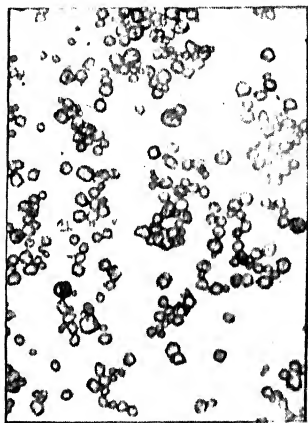


Fig. 13.

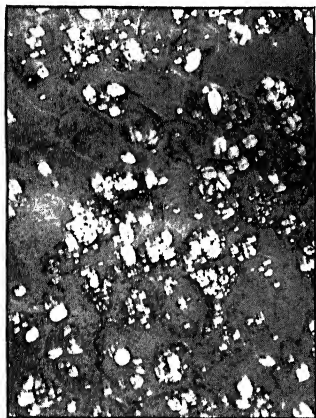


Fig. 14.



Fig. 15.

STARCHES. (Magnification $\times 120$ diams.)

12. Oat. 13. Maize. 14. Section of potato tuber with starch granules *in situ*. 15. Potato starch (polarised).

When examined microscopically starch shows an organised structure and shares with cellulose this peculiarity of a carbohydrate. Each particular group of starches possesses its own shape, appearance, and size (Figs. 8-15); thus, the tuber starches are oval or even of the form of an oyster-shell, and exhibit both concentric rings and a hilum, especially if previously treated with a few drops of weak caustic alkali; example, potato, arrowroot, and cassava or manioc starches so appear when thus examined; if polarised light and selenite plates be used as extraneous aids both black crosses and a display of colours are to be observed.

Many of the cereal starches form spheres or have a minute orange-shaped appearance of varying size, and show both the hilum and concentric rings—*e.g.*, wheat, rye, barley, and corn-flour. Rice starch, on the other hand, is very small and angular or even polygonal. It exhibits neither hilum nor rings.

The only starches of interest to the confectioner are those from wheat, rye, maize or cornflour, and rice.

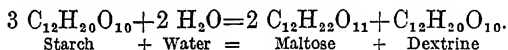
Cellulose, Lignose, or Woody Fibre ($C_{12}H_{20}O_{10}$)_n.

Cellulose is the carbohydrate of organised structure that constitutes the framework of all woody tissues, and hence of paper. The purest natural form is raw cotton. When cellulose is heated under pressure with caustic alkalies, or boiled with dilute acids, especially sulphuric acid, it is converted into glucose. Its only interest to the confectioner lies in the fact that it forms the bulk of all branny and husky particles. It is used in the manufacture of paper, parchment paper, oxalic acid, glucose from sawdust, gun-cotton, smokeless powders, celluloid, and when compressed, for wheels of railway trucks and other purposes. Celluloid, a hard gummy-like body, that readily lends itself to being stained and formed into small useful articles, is a mixture of camphor and nitrated cellulose. Its chief danger is the ease with which it becomes ignited.

The Dextrines or Amylins ($C_{12}H_{20}O_{10}$)_n.

The dextrines consist of mixtures of many isomers, and although readily soluble in water, they, like starch, form a colloidal solution incapable of filtration through filter paper and of forming crystals.

They may be prepared directly, or more commonly appear as by-products in starch transformations; example, when starch paste is heated with diastase to 145° Fah. for about half-an-hour, maltose and dextrines are formed.



These dextrines are gummy or gelatinous bodies whose aqueous solutions are dextro-rotatory, but they do not reduce Fehling's solution. When boiled with weak acids they are converted by hydrolysis into glucose, a sugar now being very largely used in confectionery and other food industries.

The Vegetable Gums.—Closely allied to the dextrines are the many gums secreted by plants, as for example gum arabic that exudes from the bark of certain varieties of the acacia tree; gum benzoin, cherry and plum gums; gum dragon, or tragacanth, and others. Gum benzoin is an aromatic gum which when dissolved in spirits of wine is employed in the trade for varnishing or glazing chocolate placques; whilst gum tragacanth is mixed with white of eggs and icing sugar to make gum paste for modelling purposes.

The Pectins.—These are a group of bodies, closely allied to the plant gums, that occur in ripe or nearly ripened juicy fruits and certain vegetables, such as apples, cherries, gooseberries, pears, carrots, barley malt, and turnips. They may best be looked upon as oxy-vegetable gums.

The pulp of apples or gooseberries is boiled to coagulate the nitrogenous matter which is skimmed off, then the gelatinous pulp containing the pectins is stored or used up at once in fruit preserving in order to assist the boiled fruit in setting and to give it body. Quite a number of these preparations are made up for the use of the confectioner for

spreading purposes, as for example raspberry and apple, which makes a nice smooth jam for Swiss rolls and other goods. The pectins may be regarded as aids to viscosity in fruit preparations.

The Glucosides.

Glucosides are an extensive group of complex bodies, really esters of glucoses with organic acids, and which occur in the organised structure of many plants. They can be hydrolysed by enzymes, acids, or alkalies, into glucose and other bodies, hence their name. The one of most interest to confectioners is *amygdalin*, the glucoside that exists with a "fixed oil" in bitter almonds, and when hydrolysed by the enzyme *emulsin* yields the essential oil of bitter almonds, which see.

FLOURS.

For an account of the cereals and their composition, together with a brief description of flour milling and flours, the reader is advised to refer to "The Chemistry of Breadmaking," by the same author and publisher, Chapters VII and VIII, pages 91 to 125. See also "Flour Milling," by P. A. Amos.

Flours are the final product of a series of operations in which a number of different kinds of wheats are separately cleaned, conditioned, and mixed in the proper proportions to form the grist that will yield suitable flours for the various uses and requirements of confectioners. The mixed grist passes through the several break rolls; the break products are separated and purified, leaving nothing but the bran and smaller offal. The purified materials consisting of angular starchy particles and known as semolinas, middlings, and dunst, next go through the smooth reduction rolls, that grind them to a fine powder, and flatten out the germs or embryos into light, thin discs that may easily be taken out of the powder or flour before it passes into the silk dressing machines. Any small lumps that tail over from these machines are returned to the reduction rolls, again crushed, and ultimately the whole of the starchy material of the wheat berry becomes dressed or finished flour.

The various grades of flours result from the admixture of the different break products ; the nearer the bran the poorer the grade of flour, hence the very best flours come from the centre of the wheat berry.

There are three grades of flour in general use : Patents including fancy patents, second patents and bakers' grades. In some districts the old Government flours, known as "straight grade," are still to be found. The quality of the whole of these flours will be determined by the composition of the grist and the thoroughness of the cleaning of the component wheats ; but it should be remembered that low grade, or frosted, or germinated wheats, if used for preparing the grist, will never produce either good straight grade flours or the high-class white flours of the present day.

Flour as milled by the above mentioned processes is a complex mixture of chemical compounds, consisting principally of starchy granules, gluten, and water, with smaller quantities of other carbohydrates than starch, certain proteins in addition to the gluten, fats, vegetable acids, and mineral salts.

The subjoined table will give the student an idea of the composition of wheat, whole meal, patents flour, and a Government "straight run" flour :

Constituents (per cent.).	Wheat.	Whole- meal.	Second patent flour.	"Straight run" flour, 1917.
Carbohydrates .	68·98	69·28	71·52	70·91
Water . .	13·79	13·49	14·92	13·88
Proteins . .	12·38	11·87	12·16	12·85
Cellulose (husky fibre) .	2·24	2·28	0·21	0·65
Fats . . .	1·26	1·52	0·57	0·79
Mineral salts .	1·35	1·56	0·62	0·92
	100·00	100·00	100·00	100·00

Properties of flours.—The most important properties of flours are colour, absorbing power, strength, and purity.

The *colour* of the best strong flours is a creamy yellow shade and very “bloomery.” The medium strength flours vary considerably in colour from a fine cream to a dirty yellowish-grey. Weak or soft flours, especially those milled from English wheats, are generally greyish-white to a dull dark grey colour. The colour of the old Government “straight run” flours when Pekarised was so variable as almost to defy a description. Roughly, they may be said to have been all shades of greyish-yellow to brownish-grey, or similar to an Allinson meal with the coarse branny particles taken out with a hair sieve.

The *absorbing power* of flours depends on the nature and quality of the gluten present, the dryness and condition of the starch, and the quantity of water already contained in the flour.

The *strength* of a flour is dependent not only on the quality and quantity of the gluten, but also on the electrolytes or mineral salts in the flour, and it is a measure of the capacity of a flour to produce large-volumed goods.

By the *purity* of a flour is meant its freedom from all admixtures of starches other than wheaten starch, and all substances whatsoever that do not exist in the wheat from which the flour was originally milled.

The flours used by confectioners are classified as strong, medium, and weak or soft. This classification is based chiefly on the nature, quality, and quantity of the gluten contained in the flour. Strong flours result from blending Spring wheats, Manitobas, Russian, and Indian wheats in the grist; medium flours from a grist composed largely of Fall or Winter wheats, Argentine, and similar types; the weak or soft flours contain a large admixture of English wheats, with some small quantity of the stronger types. The English wheats yield a flour soft in character, poor in colour, but of an excellent nutty flavour when made into finished goods.

Strong flours are requisite in the manufacture of nearly all varieties of buns, scones, and other fermented goods, puff-paste of all kinds, tea, girdle, pikelets, barm, and similar cakes, cheap slabs, and most smalls. Medium flours are more suitable for intermediate types of smalls, sponge goods, cheap Madeira cakes, medium priced slabs, and like goods.

Soft flours are necessary for the best classes of cakes of nearly all kinds, especially slabs, layer cakes, gateaux, short paste, short sweet paste, open and notched tarts, shortbread of all kinds, ginger bread and all varieties of ginger cakes, parkin, tennis and golf cakes, Christmas, Easter, Russian, birthday, wedding, and all other types of high-class cakes. This list might be increased almost indefinitely, but enough is stated to indicate the proper type of flour to use.

Cornflour.—The cereal, *Zea mais*, or maize or Indian corn (Figs. 16 and 17), is the starting point for the preparation of cornflour and maize starch. There are two chief species of the maize plant cultivated, the field maize and the sweet or sugar corn; and of these there may be something like two hundred varieties grown. The two varieties more commonly cultivated are the *Zea mais indurata* or flint maize, and the *Zea mais indentata* or dent maize.

The colour of the ripened cereal is either red, yellow, or white, with other intermediate shades. The corn when ripe is harvested, allowed to mature, stripped off its cone, degermed, ground into fine meal, passed through bolt-cloths, and finally through silk dressers, yielding cornflour.

Maize or corn starch is extracted by washing and purifying the cornflour. See article on the extraction of starches from cereals. The starch is often adulterated with starches from cheaper sources, such as those from potatoes and cassava.

Rice flour, rice starch, and cones.—These are prepared by processes similar to those given under the title cornflour. Rice cones are rather coarse angular particles from the rice endosperm, not unlike fine middlings and dunst.

The starting point is the huskless berry of the *Oryza sativa* L, the ordinary cultivated rice (Figs. 18 and 19) that grows

PLATE III



Fig. 16. Maize Corn.



Fig. 18. Rice Berries.



Fig. 17. Maize Plant.



readily in the tropical regions, and forms the staple food of millions of people. The chemical composition of the maize and rice corns may be seen in the following table :

Constituents (per cent.).	Maize.	Rice (huskless).
Carbohydrates	68·69	79·44
Water	12·89	12·22
Proteins	9·67	7·62
Cellulose or husky fibre .	2·39	0·19
Fats	4·73	0·22
Mineral salts	1·63	0·31
	<hr/> 100·00	<hr/> 100·00

Meals.—Meals from the different cereals are prepared by grinding the selected and well-cleaned corn between French burr-stones ; the meal is then passed through bolt-cloths to take out the coarsest offal for use as a cattle food. The result is a finer meal that produces a more palatable, wholesome, and digestible loaf. Although all cereals may be obtained in the form of meal, only wheat and rye contain gluten, and consequently are the two cereals from which bread and smalls can be produced separately. All other meals can be used to a limited extent for mixing with either wheat or rye meals for food purposes.

CHAPTER VI.

CARBOHYDRATES (*continued*): THE SUGARS, SUCROSES, INVERT SUGARS, SUGAR OF HONEY AND HONEY, DEXTROSE AND THE GLUCOSES, LÆVULOSE, SYRUPS, FONDANTS, CARAMEL.

THE SIMPLE SUGARS OR MONOSES.

THE title "simple sugars" is intended to include all those neutral compounds or sugars beginning with the glyceroses or sugars relating to the trihydric alcohol, glycerol, $C_3H_5(OH)_3$; the tetroses; the pentoses, of which the chief members are arabinose, pectose, and xylose; and the hexoses or monoses proper, which comprise the well-known sugars dextrose, lævulose, invert sugars, mannose, galactose, and the glucoses.

Of these the only group of importance to confectioners is the hexoses, to which the general formula, $C_6H_{12}O_6$, is assigned.

They possess most of the following properties: All are soluble in water and slightly so in alcohol; all are crystallisable, diffusible, and readily pass into the blood-stream; they are powerful reducing agents and therefore reduce Fehling's solution—alkaline copper tartrate—to the red cuprous oxide, Cu_2O , while gold, silver, and mercury salts in solution are reduced to the metallic state; for example, glucose solutions are employed in the silvering of mirrors owing to the reducing action on the ammoniacal silver solution, depositing pure metallic silver as a film on the desired surface. All possess the power of rotating a beam of plane polarised light, and are therefore said to be optically active; most of them, and especially the best known members, when in solution are readily fermented by bakers', distillers', and brewers' yeasts.

Chemically, they are aldehydes or ketones, and when treated with reducing agents form hexahydric alcohols, thus dextrose when so treated yields mannite, the alcohol and chief constituent of manna, a gummy-like substance obtained from the juice of the manna ash; and if gently oxidised with nitric acid, HNO_3 , they form either saccharic or mucic. or some similar sugar acid, thus for instance dextrose may be oxidised to saccharic or even to oxalic acid.

Dextrose or grape sugar, and the glucoses.—As long ago as 1660 a granular sugar was noticed in and obtained from honey, raisins, sweet cherries, and grape must—the expressed juice of ripe grapes—and in 1792 it was found to exist in grapes, hence one of its names, grape sugar. Within the next twenty-five years methods were devised to prepare it from starch, linen rags, sawdust and paper.

It occurs naturally in animal fluids, *e.g.*, blood and urine, in eggs, honey, etc., also in many ripe sweet fruits, flowers, leaves, and roots of plants, often accompanied with an equal amount of lævulose, and as a decomposition product of plant glucosides. Dextrose may be prepared in the pure state by the action of dilute acids and enzymes or soluble ferments on the glucosides; by the prolonged treatment of dextrines and starches with dilute acids; by separating it from the sugars and other compounds found in raisins, or honey, or invert sugars, or better by the hydrolysis of a pure maltose solution.

After purification from any of the above methods of preparation, it is obtained in fine, hard, needle-shaped, crystals with one molecule of water, $\text{C}_6\text{H}_{12}\text{O}_6 \cdot \text{H}_2\text{O}$, that melt at 295° Fah. The specific gravity of the crystals is 1.386, and that of a saturated solution at 60° Fah. is 1.221.

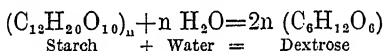
This sugar is not charred by concentrated sulphuric acid, H_2SO_4 , unless strongly heated. It is only about two-thirds as sweet as cane sugar or the pure sucroses.

The solution of dextrose is dextro-rotatory, that is, it turns a beam of plane polarised light to the right hand, hence its name dextrose. When examined in a polarimeter of the

Laurent type, its rotation is stated as : the specific rotatory power is $(\alpha)_{D_{3.86}} = +52.8$.

As previously stated, it possesses powerful reducing properties, in fact greater than those of any other sugar, hence it is taken as a standard of comparison ; the letter K stands for copper-reducing power, and for dextrose, $K=100$. Invert sugar, $K=96.6$. Lævulose, $K=92.4$. Maltose, $K=61.07$. A solution of dextrose of about 12 per cent. strength rapidly ferments with yeast or with zymin or yeast juice.

The glucoses.—The term “glucose” is generally applied to a commercial product obtained by the action of dilute acids on moist starch, and is a complex mixture, the composition of which varies with the length of time of the reaction and several other factors, but in no single instance is the action complete, so that the equation



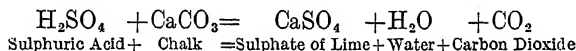
is never realised. The glucoses of commerce contain varying proportions of dextrose, maltose, dextrans, proteins, mineral salts, and water. The qualities used by confectioners, jam makers, brewers, and other food manufacturers are prepared from the cereal starches, especially Indian corn, and this accounts for the title “corn products” given to these products.

The lower grades of glucose, and those employed in the manufacture of potato and other spirits, are hydrolysed from mixtures of cheap starches or from potato starch alone, and even the use of sawdust by the Ciaassen process is quite of common occurrence.

The moist starches, intimately mixed with the proper quantity of 2 per cent. sulphuric acid solution, are brought into a large iron vessel or converter, fitted with a steam-tight lid, and capable of holding about 8,000 gallons of wet starch, heated with steam at pressures of two to six atmospheres. The pressure of an atmosphere for engineering purposes is calculated at fifteen pounds, so that the pressure at which the reaction proceeds varies between thirty and ninety pounds per

square inch. For liquid or syrup glucoses containing up to 40 per cent. of dextrines, the time in the converter is slightly over an hour, but considerably longer, say up to an hour and a half, for a crystalline sugar. The reaction is controlled by the use of a polarimeter. From the converter the syrups run into a wooden lead-lined neutralising tank to which is attached wooden stirring gear.

Here chalk or whiting is stirred in to neutralise the excess acidity, as expressed by the equation



The neutralised syrups then pass by upward filtration through tall, upright, iron cylinders or "chars," nearly filled with active, granular, animal charcoal.

The char has a fourfold function: it takes out suspended particles and colour, deodorises the thin syrups, and fully oxidises substances capable of taking up oxygen. These clarified syrups are then either bleached with sulphurous acid or hydrosulphite solutions, or sent direct from the chars to the vacuum pans, where they are concentrated to the proper consistency at temperatures below 150° Fah.

The finished liquid glucoses are then packed in casks, while the solids, after setting, are sent out in hundredweight bags. The larger quantity of the syrupy glucoses on the market are thick, viscid, colourless fluids almost devoid of sweetness, owing to the low proportion of reducing sugars—dextrose and maltose—present, and not at all suitable for use in the trade. An effort is now being made to bring into commerce some of the higher grades of glucose, say those containing 60, 70, and 80 per cent. of reducing sugars, in the form of a pale amber or even yellowish brown syrup that has not been bleached except in the chars. These would be much more effective and useful than the highly dextrinous syrups now so largely employed owing to the deficiency of sucroses, and also possess the merit of cheapness.

Already an enterprising American firm is sending out a bleached syrup known as "Sugar of Honey," that is probably

composed of a mixture of invert sugars and glucose, as it gives a plus reading on polarising, and the sweetness of which is greater than that of cane sugar.

The high quality glucoses should give a clear, bright solution in water without any sediment forming on standing; they should not contain unaltered starch that is likely to cause turbidity and a lack of brightness in the finished goods; they should leave no unpleasant after-taste on the palate, and must not have either iron salts or acidity in solution.

Their more important uses are for the preparation of all kinds of flour confectionery goods, partly replacing the sucroses, for beer worts, priming solutions, sweets, fondants, jams, table syrups and other foods, in the adulteration of golden syrups and honey, in the finishing of cotton goods, in the preparation of artificial leather, etc.

The chemical composition of the different grades of glucose may be seen from the table of analyses given below :

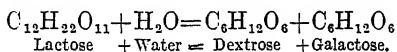
Constituents (per cent.).	High Grade.	Medium Grade.	Low Grade.	Potato Glucose.	Bleached Syrup.
Dextrose . .	72·16	66·17	51·53	53·56	43·97
Maltose . .	6·94	9·53	8·24	7·72	3·26
Dextrines . .	7·62	11·19	23·65	20·34	13·80
" " "	1·01	1·14	1·84	1·83	1·47
" " "	0·49	0·64	1·02	0·34	0·85
" " "	11·78	11·33	13·72	16·21	36·65
	100·00	100·00	100·00	100·00	100·00

Lævulose or fruit sugar or fructose.—This, the sweetest of all sugars, occurs in many ripe sweet fruits, together with approximately an equal quantity of grape sugar, hence its name fructose.

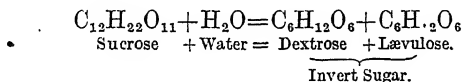
It is exceedingly difficult to obtain in the crystalline form, and is much more readily decomposed by reagents than

dextrose. Its name, lævulose, is derived from its property of bending a beam of plane polarised light to the left hand. Apart from the fact that it exists as the chief sweetening constituent in honey and invert sugars, which latter are a mixture of equal quantities of dextrose and lævulose, it is of little interest to confectioners. Lævulose is now prepared in quantity by hydrolysing the peculiar starch of the root of Jerusalem artichokes.

Similarly, the sugars galactose and mannose are only of theoretical importance in any industry at present, and as they are only slightly sweet they will not very probably be of any use in the confectionery trades. Galactose is a hydrolytic product of both lactose or milk sugar, and raffinose.



Invert sugars.—This mixture of sugars occurs in ripe sweet fruits, just as cane sugar, or more accurately sucrose, is a constant constituent of sweet unripe fruits; the ripening is in all probability represented by the enzymic hydrolysis of the sucrose, thus:



Invert sugars, as might be suspected by their source, are the chief constituent of honey; if honey be well washed on a filter with cold spirits of wine the lævulose is dissolved out, leaving the dextrose and other bodies behind, as they are less soluble in alcohol than lævulose.

Invert sugars are prepared commercially by two processes: (a) by enzyme action; (b) by the use of dilute acids, both processes being hydrolytic—i.e., the taking up of one or more molecules of water by the substance acted upon and its consequent breaking down into simpler bodies. The enzyme process is the one generally adopted in breweries. A 10 per cent. solution of sucrose is prepared and a sufficient quantity of active, vigorous yeast well stirred into it; this mixture is

transferred to a jacketed pan (Fig. 20), somewhat like the ones employed for fruit preserving, and the temperature raised to 132° or 135° Fah. by running hot water through the jacket. At such temperatures the fermentative enzyme, zymase, of the yeast is destroyed, but the invertase (also known as saccharase and sucrase) or enzyme that hydrolyses and inverts the sucrose is most active. In a few hours the reaction is complete, after which it is only necessary to boil the inverted

liquor by passing steam through the jacket in order to prevent further and injurious action, such as that induced by bacterial agency.

The more common inversion process is that by dilute acids, with or without pressure. The minimum quantity of 2 per cent. solution of sulphuric acid is well mixed with the sucrose solution, and the temperature of the converter raised to about 180° or 190° Fah.

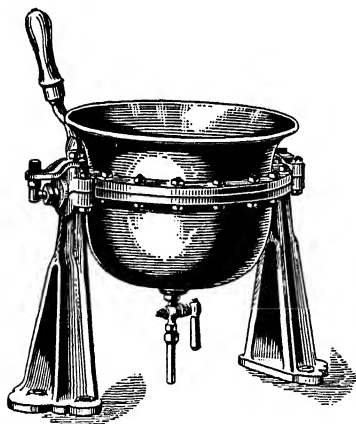


FIG. 20.—Jacketed Pan.

In thirty to forty-five minutes the reaction is complete. During inversion the process is carefully watched and frequent samples are withdrawn and polarised. At the right time the contents of the converter are run off into the neutralising tanks; here chalk or whiting is used to neutralise the acidity, the thin liquors then pass slowly through the chars and are afterwards concentrated in vacuum pans to the proper consistency at temperatures as near 140° Fah. as possible.

It is of the greatest importance that the chars should be in an active condition or the inverted syrup from a good sucrose may easily be spoiled; hence it becomes imperative to revivify the animal charcoal very frequently by destructive

redistillation. The scum taken from the chars is used as a base for the manufacture of carbolic powders and other preparations.

A high-class invert sugar well prepared is a bright, pale, amber-coloured solid or fluid, free from acidity, iron salts, arsenic compounds, or other noxious bodies ; it possesses a pleasant, very sweet taste, and is wholly soluble in water, yielding a clear solution devoid of sediment. This solution is completely fermentable, and thus it may be readily employed as a yeast food by bakers and confectioners. With the addition of a good glucose syrup such inverts may with great advantage be used in the confectionery trade for many purposes where sucrose alone is employed.

Chemically pure invert sugar is composed of equal proportions of dextrose and lævulose, with a K value=96·6, and a specific rotation of $-21\cdot3$ in a Laurent polarimeter. The commercial inverts contain dextrose, lævulose, sucrose, other carbohydrates, proteins, mineral salts and water, as a glance of the table given below will show :

Constituents (per cent.).	High Grade.	Medium Quality.	Low Class.
Invert sugar . . .	80·34	73·76	65·67
Sucrose . . .	0·62	1·65	3·22
Other carbohydrates .	0·43	5·81	8·83
Proteins . . .	0·51	0·19	0·69
Mineral salts . . .	1·73	1·68	2·95
Water . . .	16·37	16·91	18·64
	100·00	100·00	100·00

Honey.—Honey is a pleasant, slightly acid, sweet-tasting fluid collected from flowers, containing honey glands, by bees, and stored by them in the cells of combs placed in hives. Most samples of honey proclaim their origin by the distinctive odour and flavour of the fluid ; thus, heather honey and thistle-down honey may be readily recognised.

Fully three-quarters of honey consists of invert sugar, the other constituents being sucrose, dextrines, proteins, mineral salts, extractives, and water. These compounds vary considerably according to the sources, the foods, variety of bees, particular season, and other factors.

Constituents (per cent.).	Heather Honey.	Various Samples.
Invert sugar . . .	74·69	64·30 to 78·56
Sucrose . . .	3·52	0·51 „ 7·68
Dextrines . . .	1·93	0·20 „ 2·80
Proteins . . .	0·57	0·18 „ 2·00
Mineral salts . . .	0·41	0·05 „ 1·20
Extractives . . .	0·02	Very variable
Water . . .	18·86	13·20 to 31·90
	100·00	

Honey is used to some slight extent in the trade, but mainly as a distinctive flavouring agent—*e.g.*, in honey cakes, certain gateaux, nougat making, chocolate centres, etc. It might, if cheap enough, take the place of some of the sucroses as a sweetening agent. When diluted with water and fermented with yeast it gives rise to a rather sweet watery beverage known as mead, and was drunk fairly largely by the English people in the place of spirits in mediæval times.

The chief adulterant of honey is invert sugars, though both sucrose and glucose are occasionally used for the purpose.

Syrups.

Syrup is a generic term that embraces liquids prepared from sugars, sweet fruit juices, golden syrup, treacle, table syrups, glucose syrups, and many others.

In confectionery a number of sugar syrups are used for a variety of purposes, but perhaps the one generally required in “letting down” fondant for the dipping of fancies, and other uses, is of the chief interest.

Recipe.—Three pounds of white sugar with the proper amount of cream of tartar are dissolved in a pint of water, or twenty-four pounds in a gallon; then the temperature is gradually raised to about 220° Fah., care being taken to skim off all froth—coagulated nitrogenous matter—that comes to the surface. After cooling, the syrup is stored in stoppered bottles for use.

Note that half a teaspoonful of cream of tartar to eight pounds of sugar prevents re-crystallisation.

Golden syrup and treacle.—These are the refined or partially refined waste or by-products that occur in sugar extraction and refining. They consist largely of uncrystallisable sugars and water, with small quantities of sucrose, proteins, dextrans, other organic substances, and mineral salts.

Table syrups are generally mixtures of golden syrup and glucose solutions, and as a rule they possess a greater food value than the natural syrups as treacle.

Glucose syrups are merely strong solutions of medium qualities of glucose in water.

According to Sigd. Stein, the sugar expert and editor of "The Sugar Cane," these several syrups have the following chemical composition :—

Constituents (per cent.).	Unadulterated Syrup.	Adulterated Syrup.	Golden Syrup.	Glucose Syrup.
Carbohydrates .	72·2	76·9	74·7	81·6
Water	16·6	19·2	20·2	17·8
Mineral salts . .	4·0	1·1	2·3	0·6
Other organic matter	7·2	2·8	3·0	traces
	100·0	100·0	100·0	100·0

Fondants.—Two different types of fondants are in common use: those produced by the sugar boiler to be employed as sweetmeats, and for similar purposes; and the fondants

required in cake decoration in the flour confectionery industry. It is only with the latter that the trade is chiefly concerned.

Ordinary white fondant may be purchased in pails holding twenty-eight pounds weight of it; but the confectioner may easily make it as follows:—

Take four pounds of a good grade of white caster or cube sugar, one-and-a-quarter pounds or a pint of water, and eight ounces of bleached glucose syrup. The last prevents the sugar

from crystallising and also whitens and improves the gloss. Cream of tartar, juice of lemons, citric acid, acetic acid, whites of eggs, etc., can be used in the place of the glucose syrup to “cut the grain.” The sugar is dissolved in the water in a copper saucepan placed over a gas ring or clear fire, and the glucose stirred in, the temperature is gradually raised, at the same time the sugar syrup is continuously stirred and skimmed whenever it throws up a scum; the heating goes on until a temperature of 245° Fah. or “soft ball” is reached. After standing for a short time the contents of the saucepan are poured on to a marble, opalite, or other suitable slab in a cool place—the slab should be perfectly clean and slightly splashed over with water before the sugar is poured on to it—and allowed to remain until it is cold.

It should then be thoroughly worked by means of wooden or metal spoons till it assumes the characteristic non-crystalline appearance of a white well-made fondant.

It is now ready to be brought into an earthenware jar or other receptacle and stored for future use. Fondants keep best in a cool place free from dust and dirt. When required it is only necessary to “let it down” with sugar syrup at a temperature not above 90° Fah.; colour and flavour as desired for various purposes.

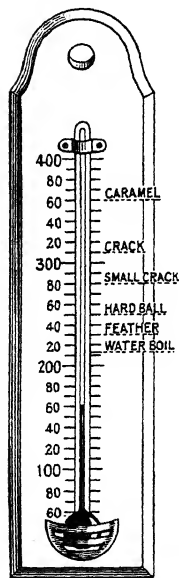


FIG. 21.
A Sugar-boiling
Thermometer.

Table of degrees of boiled sugar :—

Syrup at 220° Fah.	Soft ball at 245° Fah.
Thread at 225° Fah.	Hard ball at 250° Fah.
Pearl at 230° Fah.	Soft crack at 280° Fah.
Blow at 235° Fah.	Hard crack at 312° Fah.
Feather at 240° Fah.	Caramel at 350° Fah.
For fondant 240° to 245° Fah.	

A sugar-boiling thermometer is shown in Fig. 21.

SUCROSES AND THE HIGHER SUGARS.

This group includes all those sugars of the formula, $C_{12}H_{22}O_{11}$ and upwards to the hexahexoses, viz., the sucroses proper—cane sugar, beet, palm and date sugars, maple ash, and all others that were formerly designated cane sugar—maltose or malt sugar—lactose or milk sugar—melibiose—mucose—turanose, etc., all of the formula $C_{12}H_{22}O_{11}$. Raffinose, $C_{18}H_{32}O_{16}$. Gentianose and stachyose, $C_{36}H_{62}O_{31}$.

All the above-named sugars possess the more common properties of sugars, viz., they are all soluble in water, crystallisable, diffusible, and more or less sweet ; all, but pure surose, are capable of reducing Fehling's solution ; all possess optical properties—*e.g.*, their solutions revolve a beam of plane polarised light ; and all of them may readily be hydrolysed to less complex sugars by the action of enzymes or dilute acids.

The Sucroses, $C_{12}H_{22}O_{11}$. The sucroses are widely distributed in the vegetable kingdom in the juices of the plants in which they occur, and are invariably mixed with invert sugars, dextrines, other carbohydrates, proteins, certain sap constituents, mineral salts, and occasionally dextrose, all in an aqueous solution. Some of these bodies prevent the crystallisation of the sucroses and thus add to the extraction difficulties, whilst at the same time giving rise to molasses.

The chief sugar containing plants cultivated are :—

The beetroot, *Beta vulgaris*, containing approximately 15 per cent. of sugar.

The sugar cane, *Saccharum officinarum*, containing approximately 18 per cent. of sugar.

The sugar maple, *Acer saccharinum*, containing approximately 11 per cent. of sugar.

The sugar sorghums—

Sorghum vulgare, containing approximately 12 per cent. of sugar.

Sorghum andropogon, containing approximately 10 per cent. of sugar.

The date palm, *Phoenix dactylifera*, containing approximately 11 per cent. of sugar.

Javan and other palms that yield a sugar known as Jaggary.

Very many other plants contain much smaller quantities of sucroses that do not pay to extract.

Note that many of the palm juices are often fermented to form the highly alcoholic beverage, toddy, and much of it is distilled after fermentation, yielding the potent, ardent spirit, arrack.

All the above sugar-bearing plants, except the beetroot and maple ash, thrive best in tropical or semi-tropical countries, where the weather is both hot and dry with wet warm periods. These include the West Indian Islands, Central America, the southern portion of the United States—especially Louisiana and Florida, the northern and central South American countries, including Brazil, Peru and Demerara, the province of Northern Natal, Egypt, Madagascar, Mauritius, India, Ceylon, Java, Sumatra, Borneo, Further India, the Phillipines, Formosa, Queensland, North Australia, the Sandwich and many other Pacific Islands.

The beetroot thrives best in England, Belgium, France, South-west Russia, Austria, and Germany.

The sucroses are extracted from the different plants by processes adapted to each case: thus, from the canes by expression between powerful sets of rolls; from the beetroots by cleaning, pulping, and the diffusion or a maceration process; from the maple ash by making incisions in the bark and collecting the flowing sap:

The maple sugar is an industry peculiar to Canada and a few of the New England States of the United States.

When the sap begins to move in the early spring, long cuts are made into the bark of the trees, the collected sap is boiled in iron vessels in the woods ; this coagulates the nitrogenous matters that form a scum on the surface ; this latter is skimmed off, and when the purified juices are of the proper consistency they are run into the wooden setting trays ; after cooling the tray contents are divided into blocks and stored for future use.

In England maple sugar is employed as a sweetmeat only ; it does not keep well even in dry, cool places, but soon becomes mouldy and is thus rendered unfit for food. The composition of maple sugar varies rather widely :—

Sucrose	.	.	.	.	.	72.0 to 87.5%
Glucose	.	.	.	.	.	0.2 „ 12.6%
Proteins, etc.	.	.	.	.	.	1.4 „ 3.0%
Mineral salts	.	.	.	.	.	0.3 „ 1.9%
Water	.	.	.	.	.	7.0 „ 13.5%

The Sugar and Sugar Sorghum Canes.—When just fully ripe the canes are cut down (Figs. 22 and 23), and at once passed through the cutters that strip off any leaves and divide the canes into suitable lengths ; from the shredders they are fed into the crushing machine, consisting of belts and triple rolls of metal, between which the lengths of cane are twice pressed, thus expressing most of the sweet juice. The crushed canes, or “begasse,” are extracted with hot water to take out further sugars, extractive matters, and mineral salts, after which the exhausted begasse is used as a fuel.

The expressed ripe juice contains 75 to 80 per cent. of water, about 14 to 16 of crystallisable sugars, less than 2 per cent. of invert sugar, with small quantities of organic bodies, and mineral salts. The sugar juice is clarified by heating with lime and sulphurous acid, evaporated at reduced pressures in a faintly alkaline state, and crystals of raw sugar are obtained. By treatment of a similar kind, the molasses yield

two or three crops of crystals, each one inferior in quality to the preceding one.

The waste juices extracted from the megass or begasse are worked up into low grades of sugar or mixed with a quantity of almost spent molasses, fermented, and distilled to yield Jamaica rum.

The chemical composition of the raw sugars varies considerably :—

Sucrose (cane sugar)	.	.	.	72.50 to 94.5%
Invert sugars	.	.	.	2.30 „ 10.6%
Proteins, etc.	.	.	.	0.40 „ 9.8%
Mineral salts	.	.	.	0.20 „ 1.8%
Water	.	.	.	1.00 „ 5.8%

Beet Sugars.—Raw sugars are extracted from beet roots (Fig. 24) by thoroughly washing, slicing, and grinding the slices to a pulp, which latter is treated in iron diffusion cylinders with water, or the pulp is macerated with water to extract the sugars. The extracted aqueous juice is clarified, evaporated, and the crystals separated from the uncrystallisable syrup or molasses.

The raw juice from freshly pulped beets contains from 9 to 16 per cent. of sucrose, and from 77 to 81 of water.

The average composition of raw beet sugars is :—

Sucrose (beet sugar)	.	.	.	93.5%
Organic bodies	.	.	.	2.0%
Mineral salts	.	.	.	1.8%
Water	.	.	.	2.7%

100.0%

Sugar Refining.

The various kinds and qualities of raw sugars are imported into the British Isles and there worked up into the sugars of commerce. The processes of sugar refining are highly technical, require a good knowledge of both chemistry and mechanical engineering, but are extremely interesting to the majority of the users of sugars.



Fig. 22 Cutting Sugar Cane.



Fig. 23. Young Sugar Canes.

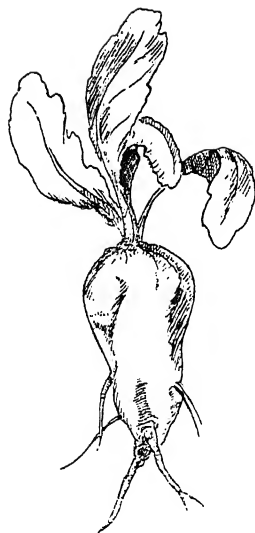


Fig. 24. Sugar Beet.

The following is an outline of the procedure adopted in several large sugar refineries in this country.

The raw beet and cane sugars are blended as required, washed somewhat in screw-troughs with cold water, then dissolved in the minimum quantity of hot water, the solution filtered, boiled down at a vacuum of about twenty-seven inches, and a temperature below 150° Fah., crystallised, and the mass passed into the centrifugals to separate the crystals from the syrup (Fig. 25). This latter is worked up into table syrups and treacle of various grades.

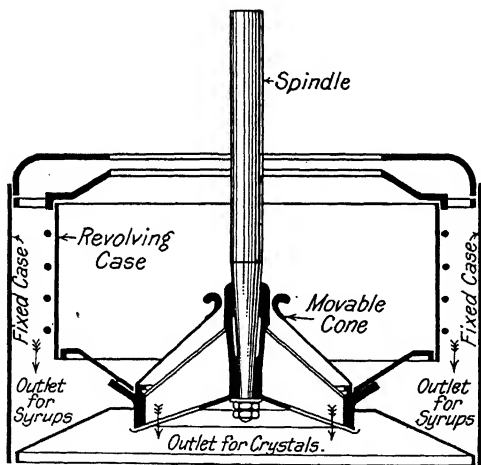


FIG. 25.—Sugar Centrifugal for separating crystals from syrups.

The rough sugar crystals are again dissolved in hot water and passed by the downward process in thin trickles through the chars. (A char lasts about thirty or thirty-three hours in continuous work, and must then be revived). During the last three years the char process has been partly or wholly replaced in some refineries by a patented method in which a substance known as "Norite" is employed. Some of the

clarified syrups and results that have come under the author's notice seem to show that Norite is more effective than the char, and it possibly has a future before it.

The clear syrup is again concentrated in the vacuum pans, crystallised, whizzed in centrifugals to take out the syrups, which are treated by a repetition of the above described processes, and made to yield lower grades of sugars. In this way three or four qualities are obtained :—

Firsts, in all forms, as crystals, super-crystals, nibs, granulated, caster-granulated, and the milled sugars—caster and icing.

Seconds closely resemble the firsts, but are slightly inferior to them ; an additional product in this class is the loaf sugar that usually appears on the market as cubes.

Thirds and *fourths* are generally put into commerce as partially refined or as raw sugars. Those portions of these grades that go out as white sugars are treated with ultramarines in order to neutralise the yellowish grey or dirty colour that cannot be removed in refining, on the same principle that a laundry puts white clothing through “ blue water ” to make the garments look whiter, or as a sugar salesman invariably places his samples on blue paper for a similar reason.

For cubes, splits, and nibs the vacuum pan product passes into special centrifugals, which cause the fine grained crystals to become caked into a hard mass ; this is removed, heated gently to dry off and harden, then cut by machinery into several sized cubes, and sieved. The finer pieces are graded into splits and various sized nibs.

Granulated sugars are prepared from small grain crystals in long double iron cylindrical granulators, that are heated and revolve during working to form the granulated sugar.

Milled sugars of various sizes are obtained by bringing rough sugar crystals into fixed drums fitted with mechanical beaters that revolve at great speed, causing the sugar crystals to strike one another and the sides of the drum with considerable force and thus break up into small particles. These particles are graded into different sizes by the action of the

sieves, yielding the three sizes of caster sugars, while the powder or finest particles go through "silks," thus forming the impalpable powder, icing sugar. The analytical figures give at a glance the chemical composition of a good sample of icing sugar :—

Total solids	98·94%
Water	1·06%
Ash	0·03%
Invert sugar	0·06%

Firsts sugars contain from 99·20 to 99·90 per cent. of sucrose, with traces only of invert sugar, mineral salts, and water, while seconds average 3 or 4 per cent. lower, with a corresponding increase in the other constituents. With sugars of such a high degree of purity as firsts it is impossible to tell their origin, but with lower grades, especially "pieces," there is little difficulty.

In the firsts it is of no importance whether a sucrose is beet or cane ; as a matter of fact, in the pre-war days, crystals, casters, etc., were very often composed of two-thirds beet to one-third cane, but in all the lower grades cane sugars are always to be preferred to the beets or sugars from any other source.

Caramel.—Caramel, or Black Jack, is a mixture of substances obtained by heating cane sugar or mixtures of sugars in an iron or copper vessel to varying temperatures, 330°—400° Fah., according to the depth of colour required, then pouring the melt into hot water with continuous stirring, allowing the turbid liquor to settle in order to get rid of insoluble, undesirable bodies, and boiling down the clear solution to the proper consistency. The semi-pasty fluid contains a number of complex compounds that vary considerably with the temperatures employed.

Amongst these will be found caramelan, caramelen, caramelin, humus, humic acids, and cellulose-like bodies.

It is well known that when sucrose (cane sugar) is gently heated in an iron spoon over a gas jet, it first melts, then

turns brown, and finally goes black, at temperatures about 360° to 380° Fah. This is the ordinary way of making caramel for colouring and flavouring gravies.

The manufactured article is used in the confectionery trade for a variety of purposes, especially the colouring of richer cakes—*e.g.*, wedding, chocolate, simnel, etc., spirits, liqueurs, beers and stouts, soups, vinegars, and vanilla extracts.

The more common uses of Sugars.

The all-important purpose of sugar is to sweeten the confectioners' goods, but certain sugars are necessary for special types of goods.

The best sugar for everyday work is a good grade of caster or fine granulated caster, especially for beating or creaming purposes, as these sugars are free in the grain and devoid of dust.

For fermented goods, partially refined raw sugars similar to the yellow primrose, are very suitable; for meringues caster sugar is to be preferred; sugar nibs are employed for sprinkling on the tops of some few goods, as for example Bath buns; they are also useful in the preserving of fruits and vegetables; when fine nibs are mixed with syrupy glucose they are quite useful in the making of cheap slabs: either glycerine or sugar of honey must be added to keep the slabs moist.

Dark treacly sugars are used either alone or in conjunction with caramel in the manufacture of very dark coloured cakes and puddings, and also to impart a luscious flavour. Icing or pulverised sugar is required chiefly in making water icing to be used in icing the tops of buns and cakes, for preparing royal icing for cake decoration, and in a few special cases—*e.g.*, in working up gum paste for modelling purposes, butter-cream, etc.

In the evaluation of sugars notice should be taken of the appearance of the crystals; clear, bright-looking sugar crystals rarely contain any impurity. Dull greyish crystals often contain invert or even glucose, and may be blued.

Bluing may easily be detected by dissolving about two ounces of the suspected sugar in half-a-pint of water contained in a glass cylinder or measuring glass, then place on a white tile or paper, allow to stand for a few hours, and look down into the glass. The blue material will have settled out to the bottom.

Sugars that contain inverts or glucose when just moistened and warmed gently for a few minutes become more or less sticky.

For the analysis of sugars, see the article on the subject at the end of the book.

FRUITS, DRIED AND CRYSTALLISED.

THE title "Fruits" in the confectionery trade is a comprehensive one, intended to embrace not only fruits, but even vegetables and flowers. Thus, crystallised angelica is the thicker portions of a hollow-stemmed plant belonging to the Umbels, that grows quite commonly in the wayside ditches particularly where a tall hedge is planted on one side of the ditch, of our country lanes; also the rhizome of the ginger plant, or the stalk of the rhubarb leaves, none of which are fruits. The only flowers of importance are rose petals and the sweet Parma violets that are crystallised and used for both flavouring and decorative purposes.

DRIED FRUITS.



These include currants, sultanas, raisins, and seedless raisins, all fruits of different varieties of the grape vine—the *Vitis vinifera*, — apples, apricots, cherries, and a few others.

To enable the vine to produce fruit in abundance and of the greatest perfection, three essential conditions must be fulfilled: suitable soils, a bounteous water supply, and a climate that is semi-tropical.

FIG. 26.—Bunch of Sultana Grapes.

These regions are to be found in the southern portions of the North Temperate Zone, and the northern section of the South Temperate Zone. The latter include the coastal districts of Australia, especially the State of South Australia, the North Island of New Zealand, and the Fiji Islands.

In the Northern Hemisphere the chief localities are : the countries bordering the middle and eastern portions of the Mediterranean Sea and the islands adjacent to these countries—viz, Sicily, the Ionian Isles off Western Greece, Candia, Cyprus, and many of the islands of the Ægean Sea. The countries included are Eastern Spain, South of France, Italy, Greece, Asia Minor, and Northern Syria ; while Persia, Afghanistan, and California are famous for their raisins.

In most of these areas the vines are grown on a south, or south-west, or westerly hillside slope, partly for drainage, and protection from the cold, boisterous, north and north-westerly winds, but mainly to obtain as much sunshine as possible.

The most productive soils are of a chalky or calcareous nature, or of gypsum, or even of hippurite limestone, such as may be found in the districts north of Smyrna in Asia Minor, from whence our supplies of the best sultanas are drawn (Fig. 26). But warm marly or loamy limestone soils are also well adapted for the growth of vines. All the above soils should be of a fatty character—*e.g.*, contain plenty of potash salts, as these are necessary for the production of tartar and sugars.

In the Northern Hemisphere when the grapes are fully ripe the bunches are cut from the vines and placed on fibre mats, while in Australia wire frames are employed. These are placed either on the ground or on a wooden frame-work so arranged that the wire mats form tiers, each about a foot from the other, so as to allow of the free passage of air currents and sunlight.

Open sheds are fixed in appropriate situations so that if rain showers come on the drying fruit may be protected. The fruit is turned occasionally in order that all parts of the fruit bunches are equally exposed to the sun and air. This has the effect of driving off the water in the grapes and of

concentrating the sugars, tartar, and other solids within the fruit.

In certain cases, as for example the Muschatel grapes that are so useful as dessert raisins and also for wine-making, the stalks of the bunches are partly cut through so as to check the flow of the sap and thus retain the sap solids as much as possible within the berries and increase the sweetness and food properties of the fruit. Sometimes the grapes on such bunches are permitted to dry on the vine, but more frequently they are cut and dried in the usual way.

Various artifices are adopted in order to soften the skin of the berry and make it glisten and appear bright and clear, thus momentary immersion in a weak, hot extract of wood ashes, or heated olive oil, or boiling water with a layer of oil on the surface. The treatment, however, varies greatly in the different countries.

South-east Spain around Alicante and Valencia, the Provence in France, Southern Italy and Northern Syria, are all famous for their raisins.

Sultanas, a form of seedless yellow grape, are produced around Smyrna, in Greece, Persia, Afghanistan, California, and South Australia. The very pale or so-called "White Sultanas," and such fruits as are nearly devoid of flavour, are bleached by exposing the dried fruit to the action of fumes from burning sulphur, *i.e.*, of sulphur dioxide gas, which also acts as a preservative on the fruit owing to its antiseptic properties.

Currants.—The name is a corruption of Corinth, the town and district on the isthmus of the same name in Greece, where the special vines produce a small, dark, luscious, seedless variety of grapes, better known as currants. There are several varieties of this species of *Vitis vinifera*, but the best are undoubtedly those grown in the Ionian Islands off the western shores of Greece. The chief of these Isles are Zante, Cephalonia, Ithaca, and Santa Maura.

The best quality fruit is the Elemé, a largish fruit of a very fleshy character, and possessing, when dried, a pleasant sweet

flavour. Currants of this size and quality are not often used by the confectioner. Small-sized fruit, as free as possible from red coloured sour berries, are generally used so as to ensure a better distribution throughout the mixture.

The well-known trade brands are—taken in the order of merit—Vostizzas, Gulf currants, Patras, Amalias, and Pyrgos. The latter three brands come from districts of these names situated in the Morea Peninsula on the mainland of Greece.

The currant vines do not bear fruit until about the seventh year, and the grapes ripen during the latter part of July and throughout August. The bunches are placed in thin layers on the drying mats, turned several times, the dried fruit leaved from stalks by hand or machinery, sifted, packed in sacks, and exported. Currants, like hops, are a precarious crop, that frequently suffers from deluges of rain during the drying period about the end of August.

Good fruit should be bold, fleshy, and clean, with a dark blue to black shade of colour, and as devoid as possible of pitted, fleshless fruit, and also of red or shanked berries that are particularly acid and readily spoil the flavour of cakes, etc.

The English currants—black, red and white—are not grapes but the fruits of a deciduous shrub *Ribes nigrum, rubrum* and *alba*, all belonging to the natural order *Grossulariaceæ*. These fruits are used in jam making, for fruit tarts, as dessert, or the preparation of a throat gargle and medicated lozenges.

Dried Apples, Apricots, Dates, Pears, etc.—In most of the temperate and semi-tropical British Colonies, and certain other parts of the world, where the temperature, climate, and soil are suitable, large quantities of apples, apricots, dates, figs, and numerous other fruits are exported in the ripened condition, or are first dried before being packed.

Stone fruits—*e.g.*, apricots, are deprived of their seed kernels, which latter are used in the preparation of the fixed and essential oils of bitter almonds; while fruits like apples, pears, quinces, etc., are deprived of their cores, that contain the seed pips encased in a stout covering of cellulose. In

some instances the pulpy fruits—*e.g.*, apples, pears, are also cut into laminæ or discs.

The fruits are then exposed to the action of the air and strong sunlight, the actinic or chemical rays of which exert a powerful antiseptic influence as well as assist in dispelling the moisture in the fruits.

When this treatment is complete the fruit is packed in lined wooden cases and stored in a dry, cool place. If required for making pies or other food preparations the discs are steeped in cold rather hard water, as such extracts only small quantities of the fruit constituents, for some hours, when a portion of the water is re-absorbed, thus rendering the fruit serviceable, while at the same time it retains its characteristic flavour, aroma, sugar, proteins, and other substances in only a slightly impaired condition.

Canada, California, Natal, and Australia are famous for these fruits.

CANDIED AND CRYSTALLISED FRUITS AND FLOWERS.

These include not only fruits but also the rinds of at least three members of the citrus fruits, angelica, ginger rhizome, etc.

Candied Peels.—The chief candied peels are those of the lemon, orange, and citron, all members of the Citrus family, the others being the lime, tamarind, mandarin, and bergamot.

The methods of conversion employed are very similar in each case, though there is considerable variation in the strengths of sugar syrups and the lengths of time occupied in certain of the processes.

Lemon peel is prepared usually from a special variety of coarse, thick-rind lemon imported from both Italy and Sicily. In other cases the peel is made from the longitudinal strips out of which the essential oil has been extracted. In the former case the fruits are cut transversely through the middle and the pulp or zest extracted; the caps, as the halves are called, then go into a brine solution for several days to take out undesirable matters and open up the rind to enable it to absorb the sugar from syrups.

From the brine solution the caps are thrown into cold water to get rid of the salt; then they are brought into a warm, dilute sugar syrup contained in tubs or tanks. Here a necessary fermentation ensues and also an absorption of sugar from the syrup; the caps pass successively through other syrups, each stronger than the preceding one, until they become saturated. The caps are then drained and air dried, forming "drained caps," which are sent out either whole or more commonly are cut up by machinery into finely cut peel, packed in seven pounds boxes, and sent into commerce.

The drained caps intended to be candied are placed on wire trays and brought into a drying room at a high temperature for several hours. This heating sets or fixes the sugar and hardens the caps, at the same time partially sterilising them and adding to their keeping properties. They are cooled in a dry, cold room, and packed whole ready for future use.

Three varieties are so obtained: the finely-cut lemon, or orange, or mixed peel, of which there are mixtures of lemon and orange, or lemon, orange, and citron. Apart from this, citron peel is invariably sent out in caps from which fresh, thin slices may be cut to place on the tops of Madeira cakes before baking, so as to assist in causing a break in the top and incidentally to impart a pleasant flavour. The break in the top is caused mainly by toughening the mixture. It is also employed in cake decoration, and internally in cakes to give flavour and aroma. All these peels are put to similar uses.

GLAZED AND CRYSTALLISED FRUITS AND FLOWERS.

They include the more common fruits, as apricots, cherries, currants (*Ribes*), plums of suitable varieties, small good-flavoured pears, the rhizome of the ginger, the stem of the angelica, etc. All the fruits should be just ripe and in the perfection of condition.

In the case of stone fruits the stone is removed by means of an instrument similar to a hair-pin, or a special kind of steel fork devised for the purpose, so that as little injury as possible is done in the removal.

The fruits are next cooked either in water or dilute sugar syrup—preferably the latter—to the desired degree of softness and allowed to drain.

A strong sugar syrup is prepared, boiled to the right degree, and well-skimmed, or the sugar is simply melted in a suitable shallow vessel, and each fruit separately dipped or rolled in the molten fluid. This ensures a coating of sugar on the outside of the fruit, which on subjecting to a dry heat gives the well-known candied or crystalline appearance to the treated fruit.

In the case of glazed fruits, as for example, cherries, the crystallising is omitted. Frequently these latter are filled with a thick syrup to occupy the space left by the stone. For the purpose of making cherry slabs or other cakes in which glazed cherries are used the thick syrup must be carefully and thoroughly washed out and the fruit dried, otherwise there is every likelihood of the cherries sinking to the bottom of the cake and thus spoiling its appearance.

Other processes are in use for the crystallising of fruits, but that given is the one in common use in the Riviera on the northern Mediterranean coast, from whence are obtained the perfection of crystallised fruits and flowers. Grasse is the centre of this industry.

The rhizome, or underground stem of the ginger, *Zingiber officinale*, is first thoroughly cleansed, cooked in weak syrup until soft, then packed in syrup in the special stone jars that are covered with a split-cane protection, and sent into commerce. Much of the best preserved ginger comes from China, especially Canton.

The ground ginger is obtained by cleaning and afterwards grinding the dried rhizome. It owes its properties to the presence of an essential oil.

Angelica, *Angelica archangelica*, a perennial, umbelliferous plant that grows to a much larger size than the wild angelica, is cultivated for the sake of its aromatic stem; it also grows quite commonly in many parts of England and Wales in ditches and swampy places. The stem, when candied,

is largely used in confectionery for flavouring, decorative purposes, and as a confection or sweetmeat. The mode of candying it follows very closely that given for candied peels.

The sweet Parma violets and rose petals are crystallised, after the stem and decayed petals have been removed, by bringing into tinned wire frames or shallow baskets, and placing one frame below the other in a stand so as to form a tier. Under the lowest frame is a tray to catch the excess syrup. Thin sugar syrup is allowed to drip through the whole series of frames until the flowers are saturated, and then they are dried at a gentle heat, or better, in the sunlight.

Both dates and figs are used to a limited extent in the trade. These fruits come chiefly from the countries bordering the Mediterranean—thus dates are abundantly grown in the oases of the Egyptian deserts and other regions. The ripe fruit is preserved mainly by drying in the sun, though occasionally dates are candied. They form an excellent flavouring and decoration for cakes after the removal of the stone.

JAM MAKING AND PRESERVED FRUITS.

In the early days of this industry the process was very simple. It consisted in picking over the dry, ripe fruit to remove stems, foreign particles, and decayed matter; then weighed quantities were brought into a copper or even iron pan with quantities of sugar, that varied between twelve and sixteen ounces per pound of fruit, and the contents boiled over an open fire until the fruit set on cooling. Such a method generally reduced soft fruits to a pulp and the sugar frequently crystallised and spoiled the jam.

The manufacturer next tried the addition of glucose syrup, to replace a portion of the sucrose, to assist in the setting of the boiled fruit, and also to act as an antiseptic and preservative due to the presence of some unchanged bleaching agent. Later, it was found that certain fruits contained larger quantities of such setting agents as the pectins and pectoses, both of which act in this way and at the same time prevent crystallisation of the sugars. This was especially the case with certain

varieties of unripe gooseberries—*e.g.*, Crown Bobs, and also acid fleshy apples. The juices of these fruits are obtained and stored after a preliminary boil, so as to sterilise and confer keeping qualities. Turnips, marrow, rhubarb, and other watery vegetable juices have now been discarded, as they are almost devoid of pectinous compounds and bulk-forming materials.

The modern methods of manufacture are as follows: The fruit is carefully picked over by girls, weighed, and transferred to the steam jacketed pan and heated up to the boil; this coagulates some of the proteins, which are removed by skimming, thus assisting to clarify and preserve the finished jam. Next, the heated sugar is added, together with the suitable fruit pulp, and a small amount of vegetable colouring matter. The mixture is then boiled by high pressure steam for twenty or more minutes, and when ready is run into the stone jars in which it is sent on the market. After cooling, the jars are covered with a waxed or oiled paper, or a disc of paper is brought on to the surface of the fruit and a small piece of paraffin wax, which if the jam is not quite cold, melts and fills up the pores of the paper cover, rendering it impervious to acid-forming germs that so readily bring about an acid-fermentation and spoil the jam.

Raspberry and apple, raspberry and strained red currant, or raspberry and gooseberry pulp produce a fine smooth preserve of good flavour well suited to the needs of the confectioner.

Jams in which the shape of the fruit is retained are quite useful for making open and closed notched tarts, but they are useless for spreading purposes as in the case of Swiss roll, or in the bottoms of pastries like cocoa-nut cuts, butter cuts, conversation tarts, macaroon tarts, and similar goods.

Closely allied to jam making is the preparation of apricot pulp, one of the indispensables of confectionery. The raw or partially cooked pulp is imported in hermetically sealed tins containing ten pounds of the pulp. This is put through a fine copper-wire sieve to get rid of skins and waste. The

waste from a ten pound tin varies between two and six ounces. The fine pulp is brought into a stew pan, together with fourteen pounds of caster sugar, and about six to eight ounces of corn-flour made into a fine batter with water. The contents of the pan are stirred continuously during the simmer or gentle boil of about an hour. During the last few minutes a few drops of egg-colour are added so as to improve the colour of the pulp. Occasionally, during the simmer, any scum of nitrogenous and other matters that come to the surface should be skimmed off as in jam making. The finished pulp is cooled and stored in stoneware jars for use as required.

Tinned and Bottled Fruits.—Confectioners may readily and cheaply bottle their own fruits for winter use by obtaining a supply of bottles such as have been previously used for sending out pineapple chunks, apricots, peaches, etc.

As there are so many variations and instructions required for the processes of bottling fruits, it is proposed in this article to give only general principles that will enable the confectioner to make a successful trial.

The bottles to contain the fruits must be thoroughly cleansed by soaking and washing in hot, but not boiling, soda water, washing and rinsing in pure cold water, and drained until quite dry by placing neck downwards in suitable racks. This assists in keeping the bottles sterile, whereas if wiped quite dry with a cloth infection is introduced by the cloth itself. The corks must also be equally well cleansed and sterilised. The fruits themselves should be freed from the remnants of the flower and stem, washed, and allowed to drain under a cover.

As previously stated, no decayed or even over-ripe fruits are permissible; in most cases the fruits are better when green and hard, but they ought to be of full growth. When dry, they are carefully packed into the bottles quite to the neck and the spaces between filled up with cold well-boiled water. Colouring agents, as weak solutions of copper sulphate (blue vitriol), or malachite green, are unnecessary and injurious to health. Nor are antiseptics required if the work is carried out

in a cleanly fashion. In our country there seems to be an unwritten law that antiseptics should be employed in order to save the trouble of scrupulous cleanliness.

The corks are forced home in the filled bottles and these brought into the cooking and sterilising apparatus, which may be a tank or large saucepan, heated either by steam, or in the oven, or over an open fire. The water in the tank is gradually raised from the ordinary temperature to that required for the purpose. The length of time for cooking depends chiefly on the nature and hardness of the fruits ; thus, with some it may be only twenty minutes, but with others about an hour may be requisite.

When the process is complete all burst bottles should be removed and loose corks again forced home. The bottles and contents are allowed to become quite cold before removal into the cool, dry storehouse. One other precaution is advisable, viz., to keep the inside of the corks quite wet, as they are then impervious to air. The method adopted is that used in conditioning bottled beers, *i.e.*, by placing the bottles on their sides or quite inverted and thus cover the corks with the liquid. Fruits preserved in this way are excellent for making plate-pies.

Fruit pulp may readily be prepared when fruit is abundant by boiling it, with or without sugar, in a jacketed pan, similar to that used in jam making. Only whole and sound fruit are permissible for this class of work. The fruit should be boiled gently at first so as to soften it, then briskly until thoroughly pulped. Generally a small quantity (about two to three grains per pound of fruit) of salicylic acid or other suitable preservative is added to prevent acid fermentation.

The pulp ought to be stored in a cool, dry place.

CHAPTER VIII.

ESSENTIAL OILS AND ESSENCES.

In the second chapter an account was given of alcohol, of beverages containing it, and some of its esters or ethereal derivatives that are of service in the preparation of essences.

In the present article it is proposed to discuss other flavourings used in the confectionery industry. Amongst these are a group of very interesting mixtures of compounds known as the essential oils.

According to E. J. Parry, our chief English authority on essential oils, the compounds occurring in these oils are chiefly terpenes, camphor compounds, geraniol compounds, aliphatic bodies, and benzene or aromatic compounds. The aromatic hydrocarbons include balsams, resins and products derived from them as the essential oils.

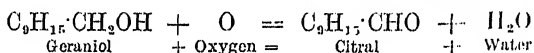
Chemically these oils bear no relationship to the paraffin or rock oils on the one hand, nor with the glycerides of food fats on the other. They are mainly hydrocarbons, aromatic alcohols, aldehydes, ketones, acids, or esters derived from alcohols, or glucosides, or they may be mixtures; thus to take a single example in order to illustrate this statement: the essential oil of lemons—one of the chief members of the Citrus family of small trees—exists in glands or cells on the outside of the rind of the lemon fruit. When expressed, say by the sponge method, it is found to be a mixture of chemical compounds composed of over 90 per cent. of terpenes and about 3 to 5 per cent. of citral.

The terpenes are hydrocarbons of the series C_nH_{2n-4} , the first member of which is oil of turpentine, $C_{10}H_{16}$. By a

hydrocarbon is meant an organic compound composed of carbon and hydrogen alone, as the formula for turpentine shows.

Limonene, $C_{10}H_{16}$, a colourless, volatile liquid, which boils at 320° Fah. (160° C.), is the chief terpene present in the oil of lemon.

Citral, $C_{10}H_{16}O$, an aldehyde is the oxidation product of a primary alcohol, geraniol $C_{10}H_{18}O$, the odoriferous constituent of geraniums, roses, neroli, limes, lavender, and other plants; when this essential oil is oxidised it yields citral:



Thus citral may be prepared synthetically by oxidising the essential oil of geraniums with chromic acid, by means of bichromate of potash and strong sulphuric acid.

Citral is a faintly yellow oily liquid of strong odour, occurring chiefly in the essential oils of oranges, lemons, limes, citrons, lemon grass oil, and in nearly all the oils of the Citrus family. The liquid boils at 446° Fah. (229° C.), has a specific gravity of 0.08971, and a refractive index of 1.4932.

The following few facts concerning essential oils may be found both useful and interesting:—

1. They are wholly volatile when pure, and therefore leave no stain on cloth or paper after volatilising.

2. They may be looked upon as being oily, odoriferous bodies, obtained chiefly from vegetable sources in the form of liquids.

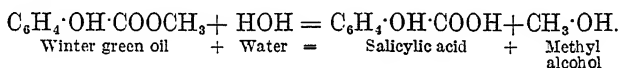
3. These oils should not be heated, as they are spoiled or even partially destroyed when subjected to the action of heat; hence oils that have been prepared by ordinary distillation have lost their fineness and delicacy of flavour and aroma.

4. They must be stored in air-tight bottles in a cool place in order to preserve them from the action of the air.

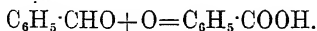
5. Some of them occur in all parts of the plant, as for example, the oils of mint used in the preparation of the liqueur Crème de menthe, and the oils of turpentine. Others occur only in special parts of plants, as for example, oil of juniper,

largely used in the manufacture of gin, occurs in the juniper berry ; oil of roses, in the petals of the flower ; oils of cinnamon and bay, in the bark and leaves ; oil of calamus or sweet flag, employed very largely in the preparation of cordials and liqueurs, exists in the rhizome or underground stem of the flag ; oil of geranium, in the flowers and leaves.

In many cases the oils exist in the free state, as already shown in the citrus essential oils ; in other cases as a glucoside, as for example, the oils of garlic, mustard, and bitter almond (see later). In a few instances the essential oil is one definite chemical compound, as in the case of winter green oil, which is methyl salicylate, $C_6H_4 \cdot OH \cdot COOCH_3$. It is a constituent of many essences, cosmetics, curative and other medicated salves, and even has its uses in the tobacco industry as an antiseptic, for when distilled with high pressure steam it is hydrolysed into free salicylic acid—an antiseptic—and methyl alcohol.



All essential oils containing aldehydes are liable to oxidise to the corresponding acid, hence all such oils must be kept in well-stoppered bottles—example, the oil of bitter almonds is composed wholly of benzaldehyde, $C_6H_5 \cdot CHO$, which liquid when exposed to the air becomes solid owing to the oxidation to benzoic acid.



From the foregoing statements the reader will probably have arrived at the conclusion that the special and peculiar odour of plants is due to the presence of an essential oil.

It may be well to remind confectioners that only the best oils ought to be used, and then only in the smallest necessary quantities.

The Essential Oil of Bitter Almonds.—The chief sources of this oil are the kernels of the apricot from Asia Minor, the kernels of peaches, nectarines, those of a few other stone

fruits, and the bitter almonds (*Amygdalus communis*) themselves (Fig. 27). All these kernels contain from 20 to 50 per cent. of a fixed fatty oil, that must be expressed before attempting to hydrolyse the glucoside amygdalin.

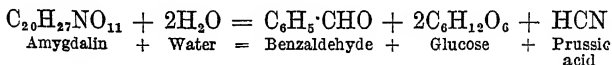
In order to do this the kernels are ground to a meal and this subjected to hydraulic pressure so as to remove the fixed oil.



FIG. 27.—Bitter Almond. One fruit with half the shell removed, showing the nut or kernel.

Fixed almond oil has a specific gravity varying between 0.9175 and 0.9251 according to its source, and an opticity of $+7.0^{\circ}$ to $+8.5^{\circ}$.

The press-cake is ground to a powder and mixed with boiling water in order to prevent frothing, allowed to cool, then fresh ground almond press-cake stirred in and macerated for twelve hours. During this maceration the enzyme emulsin contained in the fresh press-cake hydrolyses the glucoside into benzaldehyde, glucose, and prussic acid:—



When the hydrolysis is complete the mixture is distilled in a partial vacuum, to separate the benzaldehyde and prussic acid from the glucose and residue. The distillate is treated with ferrous sulphate forming ferrous cyanide; then milk of lime is added and well mixed in forming the ferro-cyanide of lime which is insoluble and non-poisonous. The mixture is filtered to get rid of the precipitated ferro-cyanide, and the oil of bitter almonds is steamed over from the filtrate.

The essential oil so prepared has a specific gravity of 1.0521 to 1.0752; its refractive index is from 1.552 to 1.554. It possesses no optical activity.

The artificial or synthetic oil is prepared from the coal-tar product toluene, $C_6H_5 \cdot CH_3$, by treating it with chlorine gas in order to form benzyl chloride, and this latter heated under pressure with milk of lime, yielding benzaldehyde. By this process traces of chlorine are always carried over into the benzaldehyde; thus it is not difficult to distinguish between the real and artificial products.

The liquid sinks in water, in which it is only very slightly soluble, but it is readily so in alcohol of 70 per cent. strength.

Almond oil extract is made by dissolving one part of the essential oil in a hundred parts of strong spirit. Oil of mirbane or nitro-benzol is a strong poison, and must not be used as a substitute.

The synthetic oil has a specific gravity ranging between 1.047 and 1.051; a refractive index of 1.543 to 1.545, both sets of figures being somewhat lower than those of the natural oil.

This oil is both stronger in aroma and harsher in flavour than the natural product, but both varieties oxidise equally readily when exposed to the air.

The Essential Oil of Angelica.—This occurs in all parts of the plant, especially in the young tender shoots and stems that are used for candying. The oil has a specific gravity of 0.8672 and an opticity of $+25.67^\circ$. It is of a pale greenish-yellow colour, and possesses an aromatic pleasant odour.

The Essential Oil of Caraway.—This oil exists in the seeds of the plant, which contain about 48 to 52 per cent. of carvone, together with some cymene, $C_{10}H_{14}$. The oil has a specific gravity of 0.9088 to 0.9132, and an opticity of $+77.3^{\circ}$ to $+80^{\circ}$. It is closely related to the oils of celery, dill, parsley and parsnip.

The Essential Oils of Lemons and Oranges.—These are produced chiefly in Sicily and the most southerly parts of

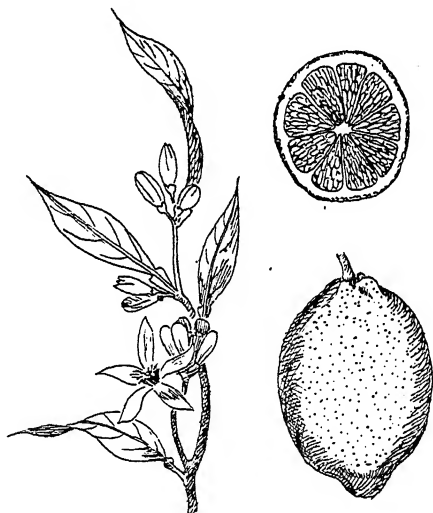


FIG. 28.—Branch of a lemon tree, showing the bloom.
On the right a whole fruit with cross section above it.

Italy. The best oils are obtained just as the fruits are ripening, during the months of November, December, and January, by the sponge and bowl process, which is considered to be superior to all other methods.

Approximately, a thousand lemons weighing almost two and a quarter cwt. yield from a pound to a pound and a half of oil. That expressed in December and January possesses a maximum in opticity and citral percentage, with a minimum

specific gravity and non-volatile residue. The characteristics of these oils are specific gravity, opticity, and citral content. Citral gives strength, flavour, and fragrance.

The district of Syracuse in the island of Sicily yields the best oil, while Palermo gives the poorest quality.

Examples :—

Characteristics.	Syracuse.	Palermo.	Other regions.	
Specific gravity .	0·8579	0·8574	0·8571	0·8582
Opticity .	+57·30°	+58°	+59°	+61°
Refractive index .	1·4755	1·4753	1·4751	1·4757
Citral percentage .	3·85%	3·72%	4·33%	4·71%

The variations are :—

Sp. gr. . . . 0·856 to 0·861 at 60° Fah.

S.R.P. . . . +56·1° to +66°.

Citral content . 3·48 to 5·22 per cent.

Oil of lemon is a pale yellow liquid of characteristic aroma and an aromatic bitter after-taste. Its chief adulterants are the terpenes, especially the residues from the terpeneless oil, white vaseline, which increases the non-volatile residue, and purified oil of turpentine.

Lemon extract is made by dissolving five parts by volume in Cologne spirit (95 to 96 per cent. alcohol) ; strong lemon oil extract, by dissolving five grams of the terpeneless oil (one from which terpenes have been distilled off), in 750 grams of Cologne spirit, and adding water to make up a litre.

The essential oils of sweet and bitter oranges are produced in and around the Syracuse area. The chief characteristics are shown below :—

Sweet oranges.

Bitter oranges.

Specific gravity . 0·848 to 0·851 0·852 to 0·857 at 60° Fah.

Opticity . . . +97° to +99·8° +90° to +94°

Vanilla and Vanillin.—Vanillin is the essential constituent of vanilla pods or beans after they have undergone a process of fermentation.

Vanillin sublimes as colourless needle-shaped crystals when the beans are gently heated. It occurs in a number of balsams and resins, but only in very small quantities.

The vanilla plant is a climbing orchid that flourishes best in Mexico, the West Indian Islands, Central America, in the northern parts of South America, especially in Colombia, Peru, and Brazil; also in the islands of the Indian Ocean, viz., Mauritius, Bourbon, and the Seychelles.

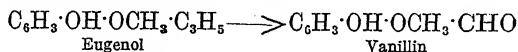
The beans, of a greenish-yellow colour and odourless, are gathered before fully ripening, and are subjected to a kind of fermentation or curing which develops the odoriferous principle, vanillin, which appears as a white efflorescence of needle crystals on the outside of the beans. After this curing process the beans are of a deep rich brown shade of colour and of a waxy feel.

The yield of vanillin varies from 1.62 to 2.74 per cent., whilst the fragrance, flavour, bouquet, and strength of the vanilla essences vary with the size and condition of the beans.

The vanilla beans contain all the usual plant constituents like, for example, hop cones, viz., sugars, proteins, enzymes, gums, tannins, resins, fats, mineral salts, fibrous or husky matter, and water.

Vanillin crystals melt at 177° to 178° Fah. (81° C.), are slightly soluble in water, but very readily in alcohol, ether, chloroform, and other organic solvents.

Vanillin is also produced synthetically by oxidising eugenol, the phenolic compound that occurs naturally in the essential oils of cloves, pimento, or allspice, bay and cinnamon with alkaline permanganate of potash.



The chief adulterations of vanilla and its products are Coumarin or Tonka bean extract, or this mixed with synthetic vanillin, or with vanillin in dilute alcohol coloured with caramel, etc.

The best extract is made by steeping the beans broken into pieces in strong alcohol for several months, the weak extract

by soaking beans in dilute alcohol and sweetening with sugar and glycerine.

A five per cent. vanilla sugar may be prepared by dissolving fifty grains of vanillin crystals in a hundred grains of strong alcohol; pouring this tincture over nine hundred and fifty grams of fine caster sugar; mixing very thoroughly; allowing the alcohol to evaporate, then grinding and sieving through a hair sieve. This strength of vanilla sugar keeps well for regular use.

ESSENCES, GUMS, SPICES.

Essence is the name given to the very large number of liquid materials that are employed in the industry as flavourings for the goods; the objects of their use being to stimulate the appetite and appeal to the sense of smell by their fragrant aroma.

The natural fruit essences possess flavours and other properties required in food production. In most instances they may be obtained directly by mixing the fresh fruits or their juices with the goods in the proper quantities.

Often, however, these flavourings are artificial essences manufactured by mixing essential oils and ethereal esters with deodorised alcohol. In this state they are easy to purchase and more readily useful; their aroma and flavour as a general rule are neither so delicate nor so fragrant as the natural flavourings of flowers, fruits and plant juices they attempt to imitate and displace.

The Preparation of Esters.

Already in the chapter on alcohols and alcoholic beverages a general method for the preparation of these bodies has been given. There are two classes of them:

- (1) the natural esters and essences obtained by extraction from their sources, and
- (2) the artificial or compound esters.

Methyl and ethyl butyrates that occur together in the essential oil of pineapples, or the methyl acetate of crude pyroligneous acid are examples of the first of these classes.

There are in addition the many oils and flavourings already set forth in the early portions of this chapter.

It will only be necessary to add a list of the more important chemically prepared esters together with their essential properties.

Ethyl Formate or Formic Ester.— $\text{H}\cdot\text{COOC}_2\text{H}_5$, a mobile liquid of pleasant, aromatic odour and cooling taste. It boils at 131° Fah. (55° C.) and has a sp. gr. of 0.9448.

Uses: In making artificial rum, arrack, strawberry, raspberry, orange and apple essences.

Ethyl Nitrite or Sweet Spirits of Nitre.— $\text{C}_2\text{H}_5\cdot\text{NO}_2$, a mobile liquid resembling the odour of ripe apples. It boils at 64.4° Fah. (18° C.) and has a sp. gr. of 0.901.

Uses: In the preparation of strawberry, raspberry, lemon, and apple essences, and also medicinally.

Ethyl Acetate or Acetic Ether.— $\text{CH}_3\cdot\text{COOC}_2\text{H}_5$, a mobile liquid of strong, refreshing odour and pleasant burning taste. It boils at 166° Fah. (74.5° C.) and has a sp. gr. of 0.9106.

Uses: It forms an excellent solvent for resins, gums, oils and lacs; is employed in medicine, and for making artificial malt vinegar, strawberry, raspberry, orange, gooseberry, lemon, cherry, and currant essences.

Ethyl Butyrate or Butyric Ester.— $\text{C}_3\text{H}_7\cdot\text{COOC}_2\text{H}_5$, a mobile liquid of pleasant, fruity odour resembling pineapples, and a burning taste. It boils at 250° Fah. (121° C.) and has a sp. gr. of 0.902.

Uses: In the manufacture of artificial rum, cheap sugar confectionery and perfumery, and pineapple, orange, strawberry, raspberry, and apricot essences.

Amyl Acetate or Jargonelle Pear Essence.— $\text{CH}_3\cdot\text{COOC}_5\text{H}_{11}$, a mobile liquid of aromatic, ethereal odour and flavour. It boils at 279° Fah. (137° C.) and has a sp. gr. of 0.8836.

Uses: Its solution in alcohol forms jargonelle pear essence; it is also a constituent of common rye or potato brandy, of camomile oil, and ordinary pear essence. Pear essence is usually a strong alcoholic solution of glycerine, amyl acetate, ethyl acetate and a few drops of essential oil of lime or citron.

Amyl Valerate or Valerianic Ether.— $C_5H_9COOC_5H_{11}$, a mobile liquid of the pleasant odour of apple juice. It boils at 370° Fah. (188° C.) and has a sp. gr. of 0.8791. It occurs naturally in angelica and valerian roots.

Uses: In making cheap sugar confectionery, apple and apricot essences.

Oenanthic Ether or Ethyl Oenanthate.— $C_8H_{17}COOC_2H_5$, a colourless liquid of the peculiar odour of brandy essence and quinces. It boils at 442° Fah. (228° C.) and has a sp. gr. of 0.8655. It exists naturally in brandies and quince juices.

Uses: In the manufacture of brandy, currant, apricot, cherry, gooseberry, raspberry, and quince essences.

Wintergreen Oil.— $C_6H_4(OH)COOCH_3$, a pale, greenish-coloured liquid that is expressed from the trailing stems of the *Gaultheria procumbens*, a plant growing in certain of the New England States of America. It possesses a peculiar and characteristic odour, and the liquid boils at 435° Fah. (224° C.) and has a sp. gr. of 1.180 to 1.187.

Uses: In curing and finishing tobacco, in medical preparations, and in manufacturing strawberry, raspberry, and orange essences.

From the above information it will be observed that the artificial fruit essences are mixtures of esters and essential oils in medium or strong alcohol.

A well-known formula expresses the general method of their manufacture: seventy to seventy-five parts by weight of rectified alcohol or grain spirit, three to five parts of pure glycerine, five to ten parts of the appropriate mixture of esters, or esters and oils, with enough distilled water to make up the whole to a hundred parts.

GUMS.

Gum Arabic, the sap of a low-growing tree or shrub that flourishes in Egypt, parts of Asia Minor, and the regions known as the Persian Gulf.

The sap exudes through abrasures in the bark somewhat like that of the cherry. It contains arabic acid as its chief constituent, and like cherry gum is soluble in water; this shows it

to be a member of the family of true gums and distinguishes it from the vegetable mucilages, that do not go into true solution, but rather form a colloidal suspension.

Gum arabic solution is used in confectionery for glazing purposes—*e.g.*, petits fours sec. Its general uses include: gums for dyers, water-colours manufacturers, for medicine, cement-making, etc. The cement is prepared by dissolving the gum in white wine vinegar, and is used for sticking together cardboard and paper sheets.

Gum Tragacanth or Dragon is an excellent example of a vegetable mucilage. It is employed in high-class confectionery work for making gum paste. *Method*: Weigh two ounces of the gum into a basin, pour over seven ounces of water, cover, and allow to stand for thirty-six hours in a cool dry place: Add four ounces of cornflour and a teaspoonful of well-beaten royal icing to toughen and give colour. The mixture will absorb about three pounds of icing sugar to form workable gum paste.

Gum Benzoin exists as a thick, resinous juice or mass that exudes from trees growing in the islands of the East Indian Archipelago, especially Sumatra, Java, Celebes, and others.

It readily dissolves, on standing, in alcohol, forming the tincture that is employed for varnishing chocolate medallions. It is also largely used in the arts for a variety of purposes. The gum when finely powdered is the chief constituent of incense that is burned in censers during religious ceremonies.

SPICES.

Spice is the name applied to a considerable number of aromatic vegetable products used as condiments in the seasoning of foods. The plants flourish chiefly in the southern portion of the Asiatic Continent, especially in the East Indian Islands. The aromatic aromas and strong pungent flavours are due largely to the presence of essential oils and glucosides. The more common of these are:—

Allspice or Pimento, the fruit of the pimento shrub which grows and thrives best in the tropical regions of America and

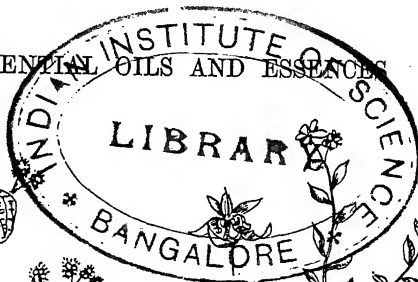


FIG. 29.—Branch of a Cinnamon Laurel.

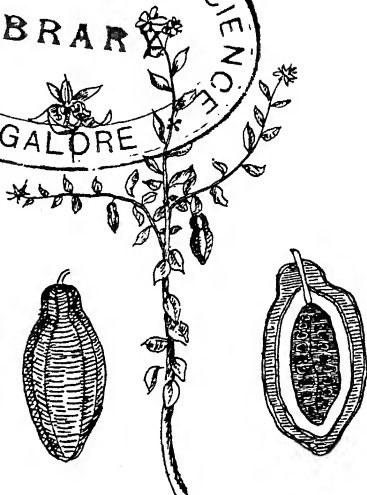


FIG. 30.—Theobroma Cacao.



FIG. 31.—Branch of a Nutmeg Tree, full of fruit.



FIG. 32.—Branch of a Clove Tree, showing the flowering blooms as used in commerce.

the West Indian Islands. It obtains its name from the fact that it is considered to possess the combined flavour of all other spices.

Capers are the flower buds of a creeping shrub, the *Capparis spinosa*. The buds when freshly gathered are pickled in a mixture of salt and vinegar, then dried and exported.

Caraway is the dried seed-fruit of the caraway herb (*Carum carvi*), not unlike parsley in appearance. It grows well south of the river Thames, and in all the south-western countries of Europe.

Cassia is the dried combined barks of the cinnamon laurel that flourishes in Ceylon and other Eastern isles.

Cinnamon (Fig. 29) is the dried inner bark of the cinnamon laurel; this forms the chief point of distinction from cassia, which is coarser in aroma and flavour.

Cloves (Fig. 32) are the dried flowering buds of the *Caryophyllus aromaticus*.

Ginger is the well-cleaned, dried, underground stem or rhizome of the *Zingiber zingiber*.

Mace is the dried seed covering or arillus of the *Myristia fragrans*—the nutmeg plant. This inner coating is deep orange in colour and of a pleasant, oily aromatic character.

Nutmegs (Fig. 31) are the kernels of the above *Myristia fragrans*, collected, dried, and exported chiefly from the Moluccas or spice islands of the Eastern seas.

Pepper is the ground, dried, fermented and cured berries of the creeper *Piper nigrum*.

Pistachio Nuts, used for flavouring and decorating confectionery high-class goods. They are the fruit seeds of the Syrian *Pistachia vera*. The kernel inside is green in colour, whilst the outer shell has a peculiar brownish mottled waxy appearance. The flavour of the kernels is something like that of a Jordan almond or Brazil nut.

OTHER MATERIALS.

Almonds are the seed kernels of the *Prunus amygdalus communis*, of which there are two varieties, the *dulcis* (or sweet) and the *amara* (or bitter).

The former is largely used in confectionery and for dessert ; the latter for the preparation of its essential oil, though for certain confections small quantities of bitter almond kernels are necessary.

Almond trees flourish best in the south of Europe, Natal, California, and South Australia, where owing to the genial, semi-tropical climate the fruits come to perfection. The trees are hardy enough to grow in most parts of the British Isles, but the fruits rarely ripen except perhaps in Cornwall.

The best Jordan almonds are imported from Spain, yet Italy, Greece, and the Levant all produce good almonds.

The kernels are used either whole or chopped, or filleted for cake-top decoration, or as ground almonds. The latter are very grossly adulterated with many kinds of cheap nut kernels, especially those of the earth or peanut.

Earth or ground nuts also form the chief bulk of ground almonds substitutes.

Before using almond kernels they must first be thoroughly cleaned from all extraneous particles, and then blanched or husked. This husking is effected by bringing the kernels into cold water, gradually raising the temperature to the boiling point, maintaining it at this for a few minutes and then rubbing on the copper wires of a sieve in order to take off the skin. The gentle heating in water also assists in softening the harder nuts. The almonds may then be filleted by hand or on a large scale by machinery. Filleted and chopped almonds are frequently adulterated.

Ground almonds may best be prepared by the special machinery devised for the express purpose, or it is possible to meal the chopped nuts by pounding in a mortar with a pestle, putting through a sieve to take out lumps, and re-pound these. The chief difficulty encountered is the oily nature of the almonds themselves.

Marzipan is a preparation of ground or pulped almonds and sugar, obtained by first steeping for some hours, thoroughly pulping, mixing with the proper quantity of fine caster sugar,

and gently boiling to the right consistency with continuous stirring so as to prevent burning.

Cocoa and Chocolate.—Both are the manufactured products of the genus *Theobroma cacao*, belonging to the Natural Order *Sterculiaceæ* (Fig. 30). The various genera of this order grow in the tropical regions of both Eastern and Western Hemispheres. The fruits of the cacao tree are drupe-shaped, and each contains up to fifty pale coloured to purple beans, that form the cacao beans of the chocolate manufacturer. The beans contain from forty to fifty per cent. of fat or cacao butter, proteins, carbohydrate matters chiefly starch, husky fibre, and traces of sugars, other plant products, mineral salts, and water.

The stimulating properties of cocoa are due to the presence of the alkaloid, theobromin, of which the beans possess from one to two-and-a-half per cent. This alkaloid is only slightly soluble in water, and possesses a somewhat bitter acrid taste.

After roasting, cooling, and shelling, the beans are ground between heavy heated rolls to melt and express the fat. Flavouring agents are added to the paste to improve its flavour, also starch, sugars, and other bodies to assist in rendering it workable.

The chief point of difference between the cocoa and chocolate is that the chocolate contains more fat than cocoa. Sweetened chocolate may be ground with over 50 per cent. of cane sugar. Both products are much less adulterated than formerly.

CHAPTER IX.

EGGS AND EGG PRODUCTS.

THE chief sources of our supply of eggs are hens, ducks, geese, turkeys, and many varieties of water fowls.

The eggs of certain members of the Saurian tribe, including turtles and some of the larger lizards, are quite good for food purposes. During the Great War South Africa exported large quantities of ostrich broken whole eggs for confectionery uses.

Many varieties of fish eggs, such as those of the shad, sturgeon, and others are employed in the preparation of special foods ; thus caviare is made from the hard roe of the sturgeon.

For confectionery purposes the chief source is the egg of the ordinary barn fowl, to which may be added, though only to a limited extent, ducks' eggs. English farmhouse eggs, when regularly collected, preferably those from the Bramah, Cochin, Dorking, Wyandottes, and similar well-known breeds, are the very best eggs for all purposes, but they cannot be obtained in sufficiently large quantities.

Irish come next in order of merit, then Danish, Finnish, Siberian, Italian, Canadian, Australian, Argentine, Spanish, New Zealand, French, China, Japan, and Egyptian. The Egyptian eggs are very small in size, averaging twelve to make a pound. They consist largely of rich yolk with but little white or albumen, hence they are valuable only for general use.

The above must not be taken as an exhaustive list of countries that supply eggs, as may be seen from the markets.

Weight and Composition of Eggs.—Eggs vary in weight (excluding Egyptians) from 40 to 60 grams ; each full-sized English egg weighs approximately 2 ozs., or eight to the pound,

and 120 (a long hundred) weigh fifteen pounds. Twelve such eggs equal a large pint in volume.

The average weight of twelve eggs:—

Hen.

Duck.

$12 \times 2 = 24$ ozs. or 680 grams. $12 \times 2.5 = 30$ ozs. or 850 grams.

Geese.

$12 \times 6.5 = 78$ (to 80) ozs. or 2300 (to 2380) grams.

Eight hen's eggs=one lb. and also=one lb. of fat for confectionery purposes.

The approximate composition of hens' eggs is: Shell and membrane 12 per cent., white 58 per cent., and the yolk 30 per cent. These figures should not be taken too literally but only as a guide. Calculated to grams they are: Shell and membrane 7.5 grams, white 32.0 grams, yolk 17.4 grams; total 56.9 grams, which equals 2 ozs., the average weight of an egg.

According to Dr. Atwater the composition of whole eggs is:

Shell	. 11.2	The shell is composed almost wholly of carbonate of lime, CaCO_3 .
Water	. 65.5	
Proteins	. 13.1	
Fat	. 9.3	
Ash	. 0.9	

100.0

According to Koenig the edible portion, *e.g.*, all without the shell, possesses the following compositions:—

Constituents (per cent.).	Whole Eggs.	Whites.	Yolks.
Water	73.71	86.69	50.81
Proteins	12.52	12.56	16.23
Fats	12.10	0.26	31.74
Ash	1.12	0.49	1.09
Organic (non-nitrogenous) .	0.55	traces	0.13
	100.00	100.00	100.00

The same authority gives the following results of analyses of the edible portion of eggs from other birds for comparison :—

Constituents (per cent.).	Hen.	Duck.	Goose.	Turkey.
Water . . .	73·8	70·8	69·9	73·6
Nitrogenous . .	13·6	13·4	13·9	13·5
Fats . . .	11·4	14·7	14·8	11·6
Ash . . .	1·2	1·1	1·0	0·9
	100·0	100·0	99·6	99·6

Whites of Eggs.—The white, or albumen, contains from 85·5 to 87·4 per cent. of water, in which are dissolved the complex mixture of nitrogenous substances including albumen, globulins, etc., and about half a per cent. of mineral salts or ash.

The whites begin to coagulate or curdle about 146° Fah., and if the heating be continued for some time it may be complete slightly above this temperature ; but if the heating is progressive and fairly rapid the coagulation is complete about 162° or 163° Fah. When once coagulated the egg albumen is no longer soluble in water. Weak acids, including such organic ones as acetic, lactic, tartaric, and others, possess the power of coagulating white of egg.

The density of the egg gradually increases from that portion next the shell membrane to the centre, consequently the whites near the shell are more watery than those that surround the yolk.

In the trade whites are employed chiefly for lightening and moistening. Whites that have been separated from the yolks and have been kept for a few days in a cool place, beat up much more readily than fresh ones, by entangling air bubbles until the contents of the containing vessel become a stiff foam. Fresh whites are improved if left exposed to the air for a few

hours though much more liable to curdle than old ones, but this may be prevented by beating up slowly and by occasional additions of sugar. Weak whites may be strengthened somewhat by storing, which permits of the evaporation of some of the water of solution; also they may be toughened by a few drops of vegetable acid solutions. Care is necessary owing to the liability of the whites to coagulate with a slight excess of acidity.

Weak whites, such as are obtained from eggs produced by fowls penned in backyards of cottages, and from certain foreign eggs of a weak nature, very much resemble water, and are difficult to beat up. The whites from ducks, geese and water-fowl eggs contain anatin and hence beat up only with difficulty.

The chief goods prepared from whites include light and heavy meringues, macaroons, royal icing, certain biscuits; they are also used for clarifying or clearing syrups and jellies.

When goods such as meringues are heated in a slow oven, say slightly over 200° Fah., they increase in volume (size) owing to the entangled air bubbles. This swelling continues until the goods are set, or, in other words, until the albumen surrounding the air bubbles is coagulated. Further heating merely browns the goods.

Yolks of Eggs.—The chemical composition of the yolk of eggs is very much more complex than that of the white. It contains such nitrogenous bodies as albumen, vitellins, nucleins, phosphorised fats as the lipines or phospho-lipines, especially lecithin, a white solid alcohol cholesterol, a non-nitrogenous body cerebrin, a yellow pigment or colouring matter lutein, about one per cent. of mineral salts, and 49 to 52 per cent of water.

The amount of fat is 29 to 32 per cent., calculated on the amount of yolk, or 10 to 12 per cent. on the whole egg. This fat is composed chiefly of the glycerides olein and stearin, with small quantities of palmitin and other bodies.

The albuminoid compounds of the yolk coagulate when heated quickly to 175° to 178° Fah., as when eggs are boiled for table use, but when heated slowly these bodies begin to coagulate at rather lower temperatures.

If an egg be boiled "hard" and allowed to cool in the air a thin black film forms round the yolk owing to changes in the iron compound present; it is very probably due to the breaking down of the lecithin molecule, and a recombination of some of the constituent elements resulting in the formation of sulphide of iron (FeS), which is dark or black in colour. This darkening may be obviated very largely by placing the hot eggs in cold well-boiled water in order to cool.

Yolks colour, enrich, flavour, and shorten goods in which they are used; but the best results are to be obtained by using whole eggs, in which case not only the above four mentioned results are effected, but also the two additional ones of moistening and assisting the texture of goods. Yolks when used alone have a tendency to toughen the goods, and should therefore be employed in smaller quantities and, in some cases, with the addition of milk, preferably in medium quality or cheaper classes of cakes. They may also be used up in making shortbread and similar goods.

Desiccated yolks are largely employed by biscuit manufacturers.

It should be noted that generally whole eggs are capable of aerating their own weight of flour.

It is customary in the trade to weigh eggs in their shells; on breaking them great care should be taken to exclude any musty ones, for there are no known means by which the musty smell and taste can be cloaked or evaded. One such musty egg will spoil a whole batch of materials of almost any size.

During the creaming of butter and sugar in cake making eggs should not be added too early nor in too large quantity. Every addition should be thoroughly beaten in, or the texture of the cakes will be too close and the cakes themselves heavy.

The Preservation of Eggs.—When eggs are exposed to the air for some days or longer they lose water by evaporation through the shell; at the same time the small air-space at the top of an egg increases in size.

A really new laid egg will scarcely float in a 10 per cent. brine solution—prepared by dissolving 4 ozs. of common salt in a quart of cold water—but the longer it is kept the greater the evaporation, hence the lighter the egg and the nearer to the surface of the brine solution it comes. This simple process of testing eggs is infallible.

Again, when freely exposed to the air they readily become putrid, and are then poisonous. The putrefaction is brought about by bacterial action. It is necessary therefore to devise some means of preservation.

Quite a number of processes have been devised for the purpose. Among these may be mentioned: Storage in strong milk of lime; storage in strong brine solution; cleaning the outer surface of the shell and storing in water glass (silicate of soda) solution is probably one of the best of these simple processes.

Cold storage—*e.g.*, in rooms where the temperature is near the freezing point of water—is also very suitable. In these places eggs lose weight by evaporation, as previously mentioned. The efficiency of cold storage depends on the fact that at temperatures of 40° Fah. and lower, very little change of a bacterial character can take place as bacteria are dormant at these temperatures.

The best known and at the same time most expensive method is to wash the outer shell of the eggs, dry, then bring into a vacuum vessel to suck out the air, introduce a spray of molten paraffin wax, or better a solution of this wax, and store in cases in a cold store where the temperature is not above 40° Fah.

Even under these conditions the eggs acquire both a flavour and aroma. They, however, will keep fresh and edible from three to six months. The patentees of this process claim that

even after two years' storage the eggs are fit for cooking and confectionery purposes.

Broken eggs, either as whole eggs, whites, and yolks, may be preserved by the addition of suitable antiseptics, as borax, boracic acid, or mixtures of these two, salicylic acid, or mixtures of borax and salicylic acid, fluorides of the alkali metals, and a number of patent substances. The quantities vary with the particular antiseptic used ; for example, from two to four pounds of a mixture of borax and boric acid is common per hundredweight of liquid eggs.

During and since the Great War, 1914 to 1919, the world's markets have been flooded with preserved broken eggs imported from China and other Asiatic sources. They are generally mixtures of eggs of land, water, and sea fowls.

DESICCATED EGGS, DRIED EGGS OR EGG POWDER (WHOLE EGGS, WHITES, AND YOLKS).

These various products are prepared by evaporating the liquids at temperatures so low as not to cause a coagulation of the nitrogenous content. This can best be effected by working in a partial vacuum. Very many good products of this class may be bought on the open market. Others, not nearly so useful, are mixed with a drying material before being evaporated, or, in other words, they are adulterated in order to cheapen them.

Egg Albumen or Desiccated Whites.—This is prepared by evaporating separated whites in a partial vacuum at temperatures so low that no coagulation occurs. It forms a brittle, glassy, pale yellow solid, almost transparent, and devoid of taste and smell. It dissolves wholly but slowly in tepid water.

This form of egg albumen may be used in the preparation of royal icing, macaroons, for all kinds of meringues, and for other purposes. It cannot be employed in the manufacture of sponge goods or cakes generally.

For cake decoration, if a teaspoonful of glycerin be added for every 7 lbs. of icing sugar the icing will not set hard.

Desiccated albumen if heated to nearly 200° Fah. coagulates and will not then dissolve in water. It is evaluated by the amount soluble in cold water. Acids, and many mineral salts, especially those of lime and magnesia, cause egg albumen to coagulate, whilst alkalies tend to prevent such action.

"Ovo" is a yellowish brown powder containing about 90 per cent. of solids, of which 4 per cent. is mineral salts, prepared from freshly broken eggs dried at a low temperature. Most of this powder will dissolve in water. This body "Ovo" has been mentioned because it was one of the first dried egg powders placed on the market.

Desiccated Yolks.—Owing to the large percentage of fat contained in yolks (30 to 32 per cent.) it is impossible to obtain these as a powder, any more than whole milk can be so obtained. The product is a yellowish, oily, semi-pasty mass which possesses but few keeping properties.

Desiccated Eggs.—These are now prepared in enormous quantities, and put on the market as yellowish-brown granular powders. Unfortunately, there is a very decided tendency to adulterate these products with carbohydrate matter, especially maize and rice flours. This deteriorates their value and at the same time renders them only slightly to fairly soluble in water, whereas the pure unadulterated dried egg is almost wholly soluble when properly manufactured. Dried eggs are not of the same value to confectioners as ordinary shell eggs.

All desiccated egg products, except the whites, should be made into a smooth paste with tepid (98° to 100° Fah.) water or milk; the proper quantity of water should then be added, the mixture whisked sharply for a few minutes, and then allowed to stand from twenty to thirty minutes before use.

It will be found advantageous to use fresh eggs or yolks, as the case may be, with the dried ones; but even then the results are not equal to those when shell eggs alone have been employed.

THE CHEMICAL COMPOSITION OF DESICCATED EGGS.

Constituents. (per cent.)	Whites. (Koenig.)	(Eggo.)	Yolks. (Koenig.)
Water . . .	12·57	9·00	5·02
Proteins . . .	78·75	84·80	34·92
Fats . . .	4·31	0·40	53·35
Ash . . .	4·24	5·80	3·69
Other bodies . . .	0·13	0·00	3·00
	100·00	100·00	99·98

EGG SUBSTITUTES.

So far none of a satisfactory character have been obtained. Most of the so-called egg powders consist of some protein body of a cheap kind, like casein from milk, a starch, and the mixture suitably coloured with annatto, turmeric, azo-orange, or other dye.

According to Dr. Hutchison in his work on "Dietetics," custard powders are composed of starch coloured, nitrogenous matter, cream of tartar, and bicarbonate of soda.

The author has found that quite a number of custard powders consist of different varieties of starch coloured with carotin or other vegetable dye.

COLOUR AND COLOURING MATTERS.

LIGHT, like sound, consists in vibrations, but for its purpose it requires a very subtle medium, the æther or æthereal medium whereas sound waves or vibrations are conveyed by the constituents of the atmosphere.

Vibrations in the æther also constitute radiant heat, which can induce chemical action. The beams or rays of both light and radiant heat travel in straight lines in all directions from their source, as for example, those that emanate from the sun.

Rays of light can only be seen by means of dust particles floating in the air. This is well illustrated by the light from an optical lantern passing through a room filled with smoke or fog. The cone of light can readily be observed by the dancing motes or particles of smoke or fog in the beam.

Vibrations of light are not all of the same wave length ; this difference in wave length reveals itself to the eye as colour.

The parts of any wave or vibration are : length, depth, and crest. The crest is the highest point of a wave ; its length is that measured from the crest of one wave to that of the next following one ; the depth is taken from the trough or deepest part to an imaginary line connecting two adjoining crests.

Any simple kind of light may be described in two ways : (1) By stating the colour sensation, and (2) by giving its wave length, which latter is usually denoted by the Greek letter lambda, λ .

According to Sir Isaac Newton, who was the first to explain the phenomena that occur when a beam of white light is passed through a cut-glass prism, white light is a complex made up of the so-called seven colours of the rainbow. These are red, orange, yellow, green, blue, indigo, violet, of which

the red is the least bent out of its course or the least refracted, while the violet is the most refracted; hence white light consists of light beams of all degrees of refrangibility.

The before mentioned seven colours constitute the colours of the *spectrum* (the word spectrum means an appearance). If the spectrum is obtained by passing a beam of light through a prism, as in the Newton experiment, it is a prismatic spectrum.

Light or colour sensations possess three constants: *hue*, or tint; *luminosity*, or brightness, of which white is most luminous, black the least so; the third attribute is *purity* of colour.

Black is not a colour, but simply a mere blackness, or the absence of all light. White, as already seen, is a mixture of all the above seven colours.

There are, however, quite a number of colours not contained in the spectrum, for example:—

Purple, which is a mixture of red with blue.

Pink, which is a mixture of red with white.

Chocolate, which is a mixture of red or orange with black.

Magenta, which is a mixture of red with some slight blue.

Grey is merely diluted white, and, like black and white, is not a colour.

The actual cause of colour is not fully understood, as our knowledge of the internal structure of bodies is too vague. Colour in solids and liquids is most probably due to absorption and reflection. A white flower, for example, reflects equally all the constituents of white light, and hence the white colour of the flower. On the other hand, a tulip may be red or yellow, etc., because it absorbs all the colours but red or yellow, and reflects its own particular colour.

It should be noted that the light beams penetrate below the surface of the petals of the flowers.

Coloured bodies are seen under two conditions:—

- (1) By the light passing through them, or it is said to be transmitted, as with stained glass and coloured solutions;

- (2) The light is reflected from the object to our eyes, as in the case of a bright copper surface, or from very finely divided gold in water.

Primary Colours.—The *primary* colours for pigments and solutions such as are employed in confectionery are: red, yellow, blue. None of these can be obtained by the admixture of any other colours.

The *secondary* colours are prepared by mixing together two primary ones. Thus orange is a mixture of red and yellow; green is a mixture of blue and yellow; purple is a mixture of blue and red. It can easily be seen that it is possible to obtain an almost infinite variety of shades by altering the proportions of the constituent colours.

Similarly, the *tertiary* colours are a mixture of primary and secondary, or a mixture of two secondaries; as with the secondary colours there may be an almost infinite variety of shades. Some of the more common tertiary colours are: buff to orange buff, russet to a reddish-russet, plum or prune to purplish varieties of these, slate to slatish-blue, sage to sage-green, etc.

Dyers, painters, and others, make use of the foregoing principles, and from a very few colours are able to produce a great variety of colour effects; thus for example, with the three primary colours, red, yellow and blue: Blue and red give purple, and a great many shades of it; red and yellow give orange, and very many orange shades; yellow and blue yield green and greenish shades; and if the three primaries are mixed in varying proportions, shades of olive, sage, brown, russet, and almost to black, may be obtained.

THE COLOURING MATTERS.

The colouring matters available for use in confectionery are of two kinds—the natural and artificial. Most of the natural colours are obtained from plant sources, but one or two—such as cochineal—are derived from the animal kingdom.

The artificial colours are organic compounds synthesised or built up from simpler colourless tones. In most cases the raw materials for the manufacture of these colours can be

obtained from the liquid product resulting from the dry distillation of coal—coal tar—hence they are frequently spoken of as the coal tar colours.

For the purpose in question, it is advisable that the colours should be soluble in water, but some will dissolve only in alcohol, and they are simply disseminated through a sugary mass in a very fine state of division.

In the case of some natural colouring matters the full colouring power of the product is only obtained by combining the colour principle with a mineral substance, and the product is necessarily insoluble in water; it must exist in the material for which it is employed as colouring in a very fine suspension. Most of the artificial colouring matters are soluble in water, and they have therefore a distinct advantage where clear transparent effects are desirable.

The following is a list of the principal colours available for the confectioners' use:—

NATURAL.

ARTIFICIAL.

Reds and Oranges.

Cochineal,
The colouring matter contained
in fruit and vegetable juices,
Beet red.

Magenta,
Azo dyes,
Eosines.

Yellows.

Turmeric,
Egg yolk,
Annatto,
Carrotin (carotene),
Marigold,
Saffron.

Acid yellow,
Azo colours.

Greens.

Chlorophyll and allied
substances,
Spinach juice.

Malachite green.

Blues and Violets.

Indigo,
Orchil,
Woad

Ultramarines.

It is particularly desirable that all mineral colours should be excluded from the confectioners' list, for many are distinctly poisonous (compounds containing copper, arsenic, lead, antimony, mercury, and barium), for they possess no advantages in adaptability over the natural and coal tar colours.

Of the coal tar colours, the compounds to be avoided are the nitro-derivatives, such as picric acid, the picrates, and naphthol yellows. The azo dyes are generally harmless if carefully prepared and selected.

Colours used in confectionery should be unchanged by a 5 per cent. solution of acetic acid on the one hand, and by a dilute solution of sodium carbonate on the other.

Cochineal (carmine).—Cochineal consists of the female members of a tribe of insects, the *Coccina*, this being a species of bug which feeds and propagates on the *Coccus cacti*, that abound in Mexico in the wild state, and is also cultivated by the natives. It has been introduced with great success into the Canary Islands and Guatemala, which countries supply and form the principal sources of cochineal at the present day. The cochineal obtained from the cultivated cactus plant is much superior, and is known in commerce as *mestèque* or *grana fina*; that from the wild plant is called *sylvestra*.

The female insects are collected from the plants and destroyed either by throwing into hot water and drying in the sun or in stoves, which yields the black cochineal-zacatilla, or the insects are placed in bags and stoved at once, yielding the silver white cochineal blanco.

The Spaniards in their conquest of Mexico found that the natives had used this dye for centuries. It was introduced into this country about 1518.

The essential colouring constituent was found by Warren de la Rue to consist of carminic acid, and this substance has been investigated by Liebermann and Schunck. Cochineal gives with tin mordant a scarlet on wool, while with aluminium mordant a crimson is obtained. Acids change the colour of a decoction of cochineal to a yellowish red, and alkalis change it to a violet.

Good cochineal should not contain more than 5 or 6 per cent. of ash, and after grinding with water there should be no sediment of either talc or lead sulphate, both of which substances are used as adulterants.

Preparations consisting essentially of the alumina compound of carminic acid in the form of a decoction are placed on the market for colouring purposes, and are extensively employed as such. The carmine of the confectioner is one of these.

Lac dye and kermes are products very similar to cochineal.

Carmines, or confectioners' liquid cochineal, is prepared by the following method:—

The silver white or black variety of dried insect is brought into a muslin bag, immersed in boiling water and allowed to simmer for a time with occasional squeezing of the bag to assist the extraction of the colour. At this stage a dull red coloured solution is obtained, from which the red colour is salted out by the addition of pure strong brine; then decant off the clear, or almost clear, liquor after settling.

The precipitated colour is now treated with a mordant or colour fixing agent, *i.e.*, a mixture of aluminium sulphate and lime water, the whole mass very thoroughly ground in a mortar with a pestle, and afterwards transferred to a flask and allowed to simmer for an hour or two. The final result is a colloidal suspension of the carmine or brilliant scarlet cochineal.

Fruit Juices.—The colouring matter of fruit juices has been the subject of a considerable amount of chemical research so far as the effect of various reagents is concerned, but in most cases the colours have never been isolated, and our knowledge of their chemical composition is almost entirely based on analogy. Those which have been prepared belong to the group of organic compounds spoken of as the anthocyanines—hydroxy derivatives of the compound flavone. The anthocyanines exist in the plant in combination with one or other of the sugars, the compounds being designated glucosides, galactosides, etc.

Grapes yield cœnin, which on hydrolysis splits up into glucose ($C_6H_{12}O_6$) and cœnidin, $C_{17}H_{14}O_7$. Bilberries have been found to contain mytillin, a glucoside of mytillidin, $C_{16}H_{12}O_7$. It is an interesting fact that mytillidin has also been isolated from the flowers of the hollyhock; and, moreover, many of these compounds exist in flowers or fruits from totally different species of plants. In all probability these compounds are closely related to one another.

As early as 1644 the English chemist, Robert Boyle, noticed that plant colours from quite different sources behaved with peculiar uniformity towards acids and alkalis. Willstätter, of Zurich, and his pupils have done a considerable amount of work on the chemistry of the anthocyanines, and Muriel Wheldale Onslow, in her recent volumes, "The Anthocyanines of Plants" and "Plant Biochemistry," has collected a vast fund of information on the subject, as well as giving a record of her own observations on these complex substances.

The anthocyanines give a bright red colour with acids and green to yellow with alkalis; in some cases the colour with alkalis is changed to blue.

Owing to the difficulty of preparing sufficiently concentrated extracts at a reasonable price the fruit juices do not find extensive application as confectionery colouring materials.

Beet red is supposed to contain two colouring principles, and of these one at least belongs to the anthocyanine class.

Papaver rhœas, the bright red colour of the English poppy, though very intense is quite harmless (non-poisonous), and finds much use in the colouring of certain beverages and medicines.

From the foregoing it will be seen that many of the red, yellow, and blue colouring matters of plants exist as, or are derived from, glucosides. A *glucoside* is a compound which contains glucose (sugar) as the characteristic basic group, or is any compound which on hydrolysis yields a sugar as one of the products of the hydrolysis. Most of the glucosides are soluble in water, and they may be extracted from their plant sources by water or dilute alcohol.

Magenta.—Magenta, known also as Fuchsine, Rubine, Roséine, Azaléine, is employed to some extent in colouring meat.

It is manufactured from "aniline oil for red" by three methods:—

- (1) The arsenic acid process.
- (2) The nitrobenzene process.
- (3) The synthetic or formaldehyde process.

The arsenic acid method is not so generally used as formerly, but it is obvious that such magenta should not enter into the composition of any foodstuff, as it is impossible to render the colour entirely free from arsenic, which substance is well known to be an accumulative and deadly poison.

The second method is the one now generally employed, but the product obtained by the process is by no means ideal as a constituent of foodstuffs. It is liable to contain small quantities of nitrotoluene, which is a toxic or poisonous body.

The third or synthetic process is decidedly the best for the purpose in question, as it yields a product consisting of pure trimethyl rosaniline hydrochloride. This is sold under the name "new magenta" and is more readily soluble in water than ordinary magenta made by the other processes, which yield mixtures of rosaniline and pararosaniline hydrochlorides. The rosaniline hydrochlorides are derivatives of triphenylmethane. They are all soluble in water, forming deep red solutions.

Eosines.—Eosine is generally sold to confectioners under the name of carmine. It forms deep red solutions in water and alcohol, which exhibit the characteristic fluorescence when the solutions are very dilute.

Rhatany.—Rhatany root, the *Krameria triandra* from the Antilles, gives a fine reddish-brown shade of colour suitable for sugar colouring.

Alkanet.—The alkanet root contains a red colouring matter that may be extracted with petroleum ether. It is also readily soluble in fats, colouring them from rose red to purple.

The alkanets belong to the boraginaceæ tribe, and are commonly cultivated in Devonshire, Somerset, and the South.

Safflower.—Safflower consists of the dried flowers of a kind of thistle, *Carthamus tinctorius*, cultivated in Egypt and some parts of India. It contains two colouring matters: one a yellow, which is soluble in water, amounting to 26 to 30 per cent. of the total weight of the safflower, and has the formula $C_{16}H_{20}O_{10}$; the other a pink colour which is regarded by the dyer as the only valuable constituent. This colour is known as carthamin, and the product contains not more than 0.3 per cent. of this compound. The alkaline solution of it is yellow, but red carthamin is thrown down on the addition of tartaric acid. The solution in alcohol is red, but it is turned yellow by acids and alkalis. The yellow colour which is used in food colouring becomes brown on exposure to the air.

Annatto.—Annatto consists of the pulpy fermented fruit of the *Bixa orellana*, the chief source being Cayenne (Guiana, South America), and is sold either as an orange-coloured paste or in the form of small seeds having an orange covering. The colour principle bixin, $C_{28}H_{34}O_5$, is practically insoluble in water, but readily soluble in alcohol, ether, and alkalis.

Annatto is not altered by acetic acid. It is now rarely used in the dyeing industry, but is still employed in colouring butter, margarine, cheese, and milk.

The following test serves for the detection of annatto in food substances:—

Example: a fat. A few grams of the clear filtered fat are shaken with about five c.c. of warm dilute (10 per cent.) caustic soda solution. The mixture is poured on to a wet filter and kept warm until the greater part of the water has run through. The melted fat is then poured off the filter paper, which is gently washed with cold water. In the presence of annatto the filter paper is stained a reddish yellow, which on moistening with a 5 per cent. solution of citric acid becomes pink. The reaction with citric acid is distinct even in the presence of mere traces of annatto.

Marigold.—The colouring matter of the marigold is probably an anthocyanine derivative.

Saffron.—Saffron is the name given to the dried stigmata of the flower of the *Crocus sativus* obtained from France—chiefly Avignon—and Spain. About a hundred thousand stigmata are required to produce a pound of saffron. It has a somewhat agreeable odour but a bitter taste, and yields a yellow colouring matter known as saffronin, or crocin, that is soluble in water and alcohol. The fact that this dye changes from yellow to brown on gentle heating (300° to 400° Fah.) is an explanation of the peculiar behaviour of certain yellow colouring materials used in the trade.

Turmeric.—Turmeric, also known as Indian saffron, is the dye substance obtained from the underground stem or rhizome of the *Curcuma tinctoria*, a plant that grows freely in the East Indies and China.

Turmeric dissolves in alkalies with a deep reddish-brown colour; with boracic acid it becomes brownish-red, and this is changed to blue or green with a drop or two of caustic soda.

Madder.—The name given to red dyes obtained from the powdered roots of *Rubia tinctoria*. These are glucosides and derivatives of various oxy-anthraquinones. They are soluble in water.

Egg Yellow (Lutein).—The yolk of eggs contains a yellow or orange-red amorphous compound of a series of bodies known as lipochromes. These bodies vary somewhat in their properties, but lutein of the hen's egg is soluble in alcohol, chloroform, and ether. It may be separated from the chloroform solution by an aqueous solution of alkali. Practically all the products sold as "egg colouring" are substitutes, and consist of one or other of the products herein described.

Chlorophyll.—Chlorophyll, the green colouring matter of plants, has been the subject of extensive and elaborate investigations by Schunck, Machlewski, and Willstätter. Abstracts of much of this work and references to the original papers may be found in the "Abstracts of the Chemical

Society's Journal, 1906 to 1914." In addition to these investigations referring directly to chemical composition, the green colour from seventy plants, including thirty-six families, has been prepared and purified, whilst the bodies which accompany chlorophyll at different stages of plant development have been isolated.

Crude chlorophyll is extracted from dried stinging nettle leaves (other plants may be similarly treated, but the nettle gives the best yield), by means of methyl alcohol or acetone. The purified product is obtained by diluting the alcoholic or acetone extract with three volumes of water, then treating with ether to extract carotin and other impurities, and after saturating the aqueous alcoholic or acetone liquor with calcium chloride extracting with ether. The purified chlorophyll obtained in this way is a dark green substance of the consistency of wax. It is soluble in neutral solvents with a brilliant bluish-green colour.

Chlorophyll is important in plant physiology, for, in general, when the leaves of plants turn brown or at leaf-fall, the chlorophyll goes back into the plant and is thus not destroyed or lost.

Malachite Green.—Malachite green is prepared by the condensation of benzaldehyde with dimethyl aniline and oxidation of the base with peroxide of lead. It is readily soluble in water and alcohol, but the solutions are somewhat blue in shade. An allied compound is brilliant green, which shows a more decided green colour when in solution.

Indigo.—This is a blue colouring matter that has been known from a very early period in the world's history. It is obtained both naturally and synthetically. The natural product is derived from the various species of *Indigofera*.

Certain other plants also yield indigo, but only in small quantities, one source being the *Isatis tinctoria* or woad plant, that was at one time largely cultivated in Europe, and even at the present time is grown on a small scale, for the sake of its blue colour, in the Eastern counties of England.

Orchil, Cudbear, Litmus, Crotel (Crottle).—These products are manufactured from various lichens which contain certain colourless compounds, that yield colouring matters on treatment with ammonia and oxidation from the oxygen of the air.

Litmus.—Litmus is a special preparation of a lichen that is extensively used as an indicator in order to detect the presence of acidity or alkalinity in substances such as food-stuffs, etc. For example, the small red sour-tasting currants may easily be shown to be strongly acid by the aid of litmus; similarly, when flours are wetted litmus enables one to detect their acidity at once.

The treated lichen is mixed with plaster of Paris and pressed into small cubes.

THE AERATION OF CONFECTIONERS' GOODS.

THERE are three different processes by which goods may be aerated : the natural, mechanical, and by chemicals.

The **natural process** is the name given to the one in which yeast is the active agent. For an account of the life history of a yeast cell the reader is advised to study Chapter IX, on Ferments, Yeasts, Moulds, Bacteria, of the companion volume of "The Chemistry of Breadmaking," by the same author and publisher. Also see article on Yeasts in the "N.A. Review," March, 1921, by Grant.

Yeast is a microscopic plant consisting of a single cell, so small that even the keenest eyesight is unable to detect its presence unless in clusters of at least thirty or forty cells. Each minute cell forms a perfect plant, the cell-wall of which is composed of two layers of cellulose ; the inside contents are an aqueous solution of protoplasm.

Protoplasm is a complex substance built up of the elements carbon, hydrogen, oxygen, nitrogen, and sulphur. In the watery solution will be found carbohydrates, fats, mineral salts, enzymes or soluble ferments, and one or occasionally two so-called empty spaces or vacuoles.

When the yeast plant is young the protoplasm is bright, glistening, tough and foamy ; as it becomes older the glistening appearance is lost, the cell-contents become granular and separate from the cell-wall.

The ordinary method of growth is by budding ; a small bud is formed inside the cell and this pushes through the cell-wall, gradually growing in size until it is nearly equal to that of the parent cell, when it splits off and commences life on its own account.

The most suitable food for the delicate little plants comprises the four proximate food principles, viz., carbohydrates, nitrogenous matter, fats, and mineral salts in aqueous solution. The best carbohydrate food is a weak solution of sugar, the strength of which should not exceed 12 per cent. The usual quantity of sugar in flour rarely exceeds 2 per cent., generally it is less than 1 per cent. Similarly, with the three other food principles only very small quantities are requisite.

Yeast lives and thrives best at temperatures between 70° and 85° Fah. It will be seen that in the routine work of a confectioner the essential requirements of the yeast are practically always observed. For example, when sponges and ferments are set in the making of fermented goods, all the necessities for the well-being of the yeast are present.

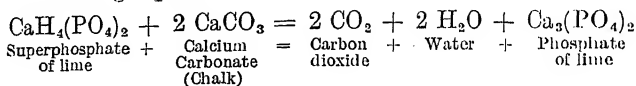
During the various stages in the work previous to baking the yeast has every opportunity under normal conditions of working and developing. It is at these stages that the yeast generates carbonic acid gas (CO_2), which aerates the goods, alcohol (spirits of wine), and small quantities of other bodies.

The **mechanical aeration** of goods by forcing, previously prepared, carbon dioxide through them has never yet been successfully accomplished. The late Dr. Daughlish attempted this method with bread doughs, but he only achieved a slight success that was not lasting. Other workers have tried similar experiments with confectioners' doughs, but with no more success. Another example is that of aeration by means of entangling air bubbles in eggs, for which see the article on eggs.

The **aeration by chemicals** was first tried towards the end of the eighteenth century by means of a mixture of superphosphate of lime and ordinary washing soda that had been dried (dehydrated). From that time onwards continuous progress has been made with this method.

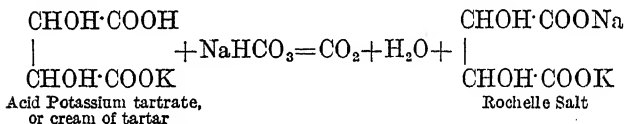
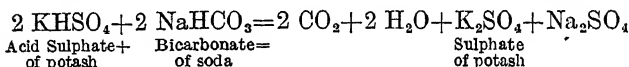
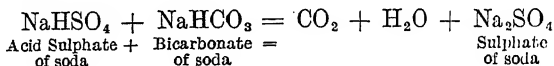
It depends on the action of an acid substance on an alkaline carbonate: thus, for example, when finely divided precipitated chalk is intimately mixed with superphosphate of lime and the mixture wetted a brisk effervescence occurs. This reaction, which results in the formation of carbon dioxide,

water, and normal phosphate of lime, may be expressed by the following equation :—



Phosphate of lime, an ordinary constituent of bones and bone ash, is left in the goods.

Other acid salts of metals are used to act on the various carbonates of soda, thus :—

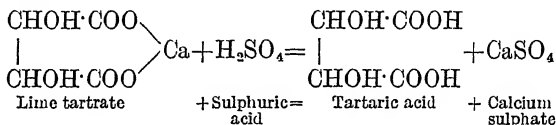


The last is by far the best of all methods and gives the best results. Neither cream of tartar nor bicarbonate of soda is very soluble in water, hence the reaction in the doughs takes place only slowly. This allows time for the making and moulding of the doughs without undue haste such as is necessary when working with tartaric acid and ordinary carbonate of soda. The goods in this case should be made up quickly and at once brought into the oven, whereas with the former they should be given from twenty to thirty minutes before baking, so as to obtain the maximum results. It requires two ounces of cream of tartar and one ounce of bicarbonate of soda to aerate four pounds of flour.

In addition to the acid salts of metals certain organic acids are used with alkaline carbonates for the aeration of goods. The more important of these are tartaric and citric acids. The last named one is the better from the dietetic point of view, but owing to its greater cost is rarely used. Malic acid, another of the fruit acids, is in the same category.

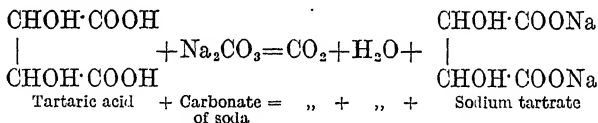
Tartaric acid, which is obtained from argol, the crude product resulting from the fermentation of "must," the expressed juice of grapes, by wine yeasts forms the starting point for the manufacture of the tartaric acids of commerce.

The argol or impure acid potassium tartrate is first purified, then the lime salt is prepared, this is also purified and afterwards decomposed by sulphuric acid according to the equation :—



The tartaric acid is crystallised out from the clear settled liquors and purified by recrystallisation.

For the confectioners' use the acid should be in the form of a fine powder. This, when mixed with a little less than an equal weight of the normal carbonate of soda, is sieved into the flour very thoroughly, say about four times. The reaction taking place, when the goods are made up, may be expressed by the equation :—



There are also a large number of so-called cream powders on the market that act as substitutes for ordinary cream of tartar. Generally, they are mixtures of acid substances with a weighting material, usually sulphate of lime, a neutral salt that possesses no value to a confectioner. The quantity of this in cream powders has been limited by Act of Parliament to 12 per cent., but often much larger quantities are found in samples that have been analysed.

The acid substances include all those given in this chapter and certain others. The favourite one appears to be acid calcium phosphate, better known as superphosphate of lime.

If this substance could be obtained pure and free from the normal phosphate of lime it would be a very useful and cheap material, but it rarely contains as much as 30 per cent. of the actual acid body, $\text{CaH}_4(\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$. The main bulk of the body is $\text{Ca}_3(\text{PO}_4)_2$, a salt possessing no acid properties, and therefore useless as an aerating agent.

- Very few of the cream powders give good results as regards volume, colour, flavour, and general appearance of the goods. Where it is necessary to use them only the best should be purchased, and then with the greatest care even in low class goods.

Baking powder, which is largely used in the industry, is composed of cream of tartar or other acid body and bicarbonate of soda in the proper proportions, together with a substance that will prevent the absorption of moisture from the atmosphere and so cause a decomposition of the two ingredients, resulting in the formation of a solid mass that has lost its aerating properties. Either cornflour or ground rice may be used for this purpose.

VEGETABLE ACIDS AND NITROGENOUS MATTERS.

VEGETABLE ACIDS.

It is very necessary that confectioners should possess some knowledge of and the effects of a few more important organic or vegetable acids on the raw materials and finished goods; acetic acid, for example, is used frequently in certain classes of work, hence a knowledge of the properties of this acid will be found useful in preventing mistakes.

The more common vegetable acids in constant use are: Acetic, the cause of acidity in vinegar; butyric, a decomposition product of butter; lactic, the fixed acidity of food stuffs; oxalic; succinic; malic; citric; and tartaric acids; together with the acid or hydrogen salts of the above named acids, since these or some of them are employed for a variety of purposes by the confectioner.

Acetic acid (CH_3COOH) is the second member of the series of fatty acids so called because the higher members of this homologous series exist as glycerides in the food fats. It is found in the juices of a few plants and in the secretions of certain animals, in all fermented doughs during the early baking stages, and in a combined state in some vegetable and animal oils.

It is manufactured by two different processes:—

- (1) By purifying the crude pyroligneous acid obtained in the destructive distillation of wood, peat, etc.; and
- (2) By the oxidation of weak alcohol solutions by means of acetic acid micro-organisms. This second process yields the various aromatic and other vinegars obtained in commerce; thus, white wine vinegar is the result

of the souring of weak white wines; similarly, red wines yield red wine vinegar; beer and ale yield malt vinegar; cider yields cider vinegar.

Raspberry and other fruit vinegars are prepared by steeping or extracting various fresh fruits in quantity in vinegar, then straining through a cloth filter, and clarifying with white of egg or isinglass finings.

Pure, strong acetic acid is known as glacial acetic, from the fact that at low temperatures it exists as glistening ice-like crystals. If either the liquor or crystals is allowed to touch the skin, blisters are formed similar to those produced by stinging nettles.

The liquid boils at 245° Fah. and has a specific gravity of 1.081. The ordinary pure, except that it is diluted with water, commercial acid contains from 33 to 38 per cent. of acidity. This is the variety used for toughening royal icing. It is also employed in the preparation of the various acetic esters that are so important in the essence industry.

The ordinary table vinegars contain from 5 to 10 per cent. of acetic acid. The acetates are the salts of this acid and they are of considerable importance.

Verdigris, basic copper acetate, is prepared by allowing thin sheets of copper to stand in the strong acid with a portion of the sheets exposed to the air: it is also found on copper or brass utensils employed by confectioners if these vessels are left dirty for a day or two after containing sugars or saccharine fluids. Verdigris appears as a green or greenish-blue deposit on the copper or brass appliances. It is a strong poison and very liable to cause blood-poisoning.

Butyric acid ($C_3H_7\cdot COOH$), the fourth member of the fatty acid series, occurs both in the free state and also combined in natural products. Wherever filth and certain kinds of organic matter are allowed to collect, butyric acid bacteria, belonging to the termo groups, give rise to the free acid. This is especially the case during moist, hot weather, in dirty untidily-kept confectionery establishments. Its presence in the free state leads to the formation of diseases in goods.

When butter becomes rancid, the nauseous odour is due to the free butyric acid. The salts and esters or ethereal salts are known as butyrates, the esters of which find much use in the manufacture of essences.

Lactic acid ($\text{CH}_3\cdot\text{CHOH}\cdot\text{COOH}$), the "fixed acidity" of food stuffs, is formed by the action of the many groups of lactic acid bacteria on carbohydrates in the presence of nitrogenous matter, therefore it is invariably found in all carbohydrate foods and beverages, especially milk, in which case an excess causes the curdling or coagulation of the casein compounds. It is also present in all over-fermented and over-proved doughs of all kinds. In the free state it exists as a viscid, sour-smelling, brown-coloured liquid, although colourless when pure. It finds great use in cheese manufacture, for the souring of worts in distilleries and even in ale and beer breweries.

It is regarded as the "fixed acidity" of food stuffs because it is not volatile in steam, but if strongly heated it begins to decompose; whereas acetic acid or the "volatile acidity" readily passes over quite unchanged when subjected to steam distillation.

The salts of lactic acid are the lactates, of which the best known are those of the alkali metals, of lime and of zinc.

Oxalic acid $\left\{ \begin{array}{c} \text{COOH} \\ | \\ \text{COOH} \end{array} \right., 2 \text{H}_2\text{O}$ $\left. \right\}$, is the oxidation product

of sugar brought about by heating a solution of sugar with nitric acid. It may be prepared commercially either by the fermentation of sugar solutions with the aid of moulds, or by fusing sawdust with a caustic alkali, which gives the oxalate or salt of the alkali metal. This melt is dissolved in water, filtered from sediment, the lime salt prepared and this decomposed by dilute vitriol to set free the oxalic acid. The solution is again filtered to free it from sulphate of lime and the free acid crystallised and purified by recrystallisation. It exists as long prismatic needles, and is very poisonous. Oxalic

acid exists in the common wood sorrel, also as its acid salts in many other plants—thus, in rhubarb stems and leaves, in the leaves of the garden and sugar beets.

The acid potassium oxalate and the free acid form a poisonous salt known as salts of lemon or sorrel. It is employed in bleaching straw fibres, taking out iron-mould stains from all kinds of cloth and sundry other uses. Oxalate of lime occurs in all deposits from fermenting yeasts.

Succinic acid $\left\{ \begin{array}{c} \text{CH}_2\cdot\text{COOH} \\ | \\ \text{CH}_2\cdot\text{COOH} \end{array} \right\}$, a white solid compound pre-

pared by distilling refuse amber, is one of the substances produced in small quantities in the alcoholic fermentation of sugars.

Malic acid $\left\{ \begin{array}{c} \text{CH}_2\cdot\text{COOH} \\ | \\ \text{CH}\cdot\text{OH}\cdot\text{COOH} \end{array} \right\}$ is an important fruit acid that

exists with its acid potassium salt in unripe, sharp-tasting, sweet fruits, as the three varieties of currants (*Riber*), raspberries, grapes, rowanberries, bananas, gooseberries, blackberries, mulberries, loganberries, pineapples, cherries of various kinds, apples, and many other fruits, where it is associated with both citric and tartaric acids, and in the tobacco plant as its acid lime salt. Both the free acid and its acid potash salt are constituents of a few of the highest class effervescing beverages. The salts are the malates (from *malum*, an apple), and they are most useful in keeping the blood alkaline.

Tartaric acid $\left\{ \begin{array}{c} \text{CHOH}\cdot\text{COOH} \\ | \\ \text{CHOH}\cdot\text{COOH} \end{array} \right\}$ is one of the most widely

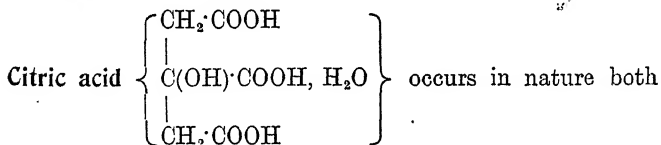
distributed fruit acids in nature, both in the free state and as its acid salts. It is closely associated with citric and malic acids, especially in the zest of the citrus fruits, also in grapes and fruits mentioned under malic acid.

Its chief source is the deposit of argol, or lees, that takes place in the fermentation of grape juice (must) by wine yeasts.

Argol is of three shades of colour, according to the colour of the grapes from which it is obtained. The argol is purified and decolourised, yielding the cream of tartar of commerce, a salt so largely used by the confectioner in the aeration of powder goods. The free tartaric acid is manufactured in quantity from purified argol, and other raw materials, by first obtaining the lime salt and decomposing it with dilute sulphuric acid: the calcium sulphate is filtered off and the tartaric acid crystallised out. For confectioners' use this crude acid must be purified by re-crystallisation.

Its salts are the tartrates, of which there are two series: the acid or bitartrates represented by cream of tartar, and the normal salts represented by Rochelle salt.

For the methods of using tartaric acid and cream of tartar in the trade see the article on "Aeration," Chapter XI.



as the free acid and its acid salts in most of the fruits enumerated under malic acid; also in all the citrus fruits—strawberries, cranberries, sloes, etc.

The zest pulp from lemons is boiled with chalk so as to obtain the lime salt. The remainder of the process is similar to that given for the preparation of tartaric acid.

Citric acid may also be prepared by fermenting a solution of glucose with a mould fungus, that yields carbon dioxide, citric acid, and other bodies.

The acid crystallises in hard, rhombic prisms containing one molecule of water as shown in its formula; they are fairly easily soluble in water and alcohol. The solution possesses a pleasant, sour taste, and is almost in every way more suitable for the preparation of aerated beverages than tartaric acid. It is, however, more costly, but quite as easy to use as tartaric acid. Its salts are the citrates.

THE NITROGENOUS BODIES EXISTING IN RAW MATERIALS.

This subject of study is one of the most important to all those concerned with the preparation of foods, on account of its far-reaching influence, not only in the natural products themselves, but also as its compounds are the chief flesh-forming foods.

Nitrogen exists as a gas in the atmosphere, forming its most abundant constituent, where its inertness modifies or dilutes the chemical activity of the oxygen—the other and most important element of air. Yet in spite of its inertia in the free state, in combination with other elements, especially hydrogen, oxygen, and sulphur, it is by far the most important element of all food principles. Again, in combination it forms, on the one hand, the most deadly of poisonous substances, as for example, prussic acid (HCN), which is a decomposition product of the glucoside amygdalin, when hydrolysed in the preparation of the essential oil of bitter almonds; while on the other hand it gives rise to the formation of such high explosives as T.N.T. (tri-nitro-toluol), nitro-glycerine, picric acid, and the picrates.

Protoplasm—"the physical basis of life"—the nitrogenous constituent of cell-life, is another instance of its importance.

The **proteins** of vegetable life; the **albuminoids** of the animal kingdom: and the **nucleins** of all germs or embryos, are other examples of its paramount importance. One other group of nitrogenous bodies is that of the enzymes, or soluble ferments, or the activities of life.

The proteins or proteids—of which there are many—the albuminoids, and the nucleins, when subjected to the processes of hydrolysis—the addition of molecules of water and a breaking down of the large molecule—are degraded into simpler and much less complex bodies, many of which are soluble, crystallisable and diffusible, and become actual foods instead of potential ones, as is the case with the extremely complex, insoluble, colloidal bodies mentioned.

To quote Roscoe W. Thatcher: "The proteins constitute the active material of protoplasm in which all the chemical changes take place that go to make up vital phenomena, whilst combined with the nucleic acids they comprise the nucleus of the cell." (Thatcher: "Chemistry of Plant Life, 1921." Chapter on the Proteins.)

As an example of the complexity of proteins the following may be given:—

Zein, the special protein of maize, $C_{736}H_{1161}N_{184}O_{208}S_3$.

Casein, the special protein of milk, $C_{708}H_{1136}N_{180}O_{224}S_4$.

Gliadin, one of the special proteins of wheat,

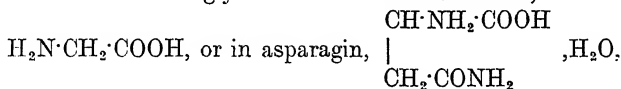
$C_{685}H_{1068}N_{196}O_{211}S_3$.

The proteins are a group of nitrogenous compounds very widely distributed in plant life, and when absorbed and assimilated by animals act as flesh formers. They are one of the most important proximate food principles. When once formed by plant activities they are stored away frequently mixed up with carbohydrates, fats, and mineral salts, as in the case of the cereals and numerous other groups of plants.

When required by the plant as a food these complexes are hydrolysed by the proteolytic enzymes into such soluble, crystalline, and diffusible compounds as the peptones, amides, amino-acids, and even simpler derivatives.

The **amino-acids**, now recognised as of the highest importance, may best be considered as fragments of a protein providing strong acids and bases. Many of them possess a sweet taste and most are readily soluble in water.

The name is given to a group of nitrogenous compounds in which an amide group— NH_2 is directly attached to a carbon atom, as for example in the general formula $R \cdot H_2N \cdot CH \cdot COOH$, or for instance in glycocoll or amino-acetic acid,



the amino compound which exists in asparagus heads, in cereal rootlets and elsewhere. It forms an excellent animal and yeast food.

Most of the proteins and many of their more complex hydrolytic products have a percentage composition varying between :—

Carbon.	Hydrogen.	Nitrogen.	Oxygen.	Sulphur.
49.0	6.3	14.9	19.8	0.3
to	to	to	to	to
55.2	7.4	19.6	25.5	2.6

These complex bodies exist in almost all the raw materials employed by confectioners, as in flour, meals, milk, fats, certain of the colouring matters, and eggs. Perhaps it may suffice for the confectioner to remember that all proteins are readily affected by the action of heat and acids causing a curdling or coagulation which alters their composition, rendering them insoluble and practically useless for the purposes required. Typical examples may be found in flours, milk, whites, yolks, and fats.

The enzymes, or soluble ferments or activities of cell and other forms of life, are of nitrogenous origin, which when under suitable conditions are able to bring about the many and wonderful changes attributed to them. A study of them is far too difficult a problem to be undertaken in a small volume on "Confectioners' Raw Materials." A wide knowledge of physical and colloidal chemistry is necessary in order to adequately understand them.

CHAPTER XIII.

SOME GENERAL METHODS OF USING THE RAW MATERIALS.

It is requisite thoroughly to understand certain general principles before considering the actual mingling of the ingredients. These include scrupulous cleanliness of person, clothing, utensils, materials, and work-rooms, in the last of which there ought to be plenty of light and air. The materials ought to be suitably stored according to requirements.

All the appliances should be placed ready for use, and under no circumstances put away in a dirty state. Neglect of these points means loss of time and possible chances of infection. There must be a punctuality in everything, and all work should be undertaken in an orderly manner.

All weighings and measurements must be strictly accurate. The worker should possess a good practical knowledge of the work as well as of the raw materials themselves. In addition, the responsible person must be able to follow the markets regularly so as to be in possession of the buying and selling prices.

As a last requirement there should be a very real liking for the work itself, for it is only the enthusiast who will probably reach the highest positions in the confectionery industry.

Items of general knowledge likely to prove useful are as follows :—

It has been stated previously that a pound of eggs will aerate an equal weight of flour, and it is also equivalent to a pound of fat.

A coldness of the materials, especially the eggs, is a common cause of weak batters curdling ; while on the other hand,

if the temperatures are too high, a similar result is experienced. The most favourable temperatures for butter and sugar batters—the creaming up process—are between 66° Fah. and 72° Fah.

Again, very fine rather soft-grained sugars are likely to cause the rapid liquefaction of the batters.

From this it would appear that sharp-grained, rather hard caster sugars are very suitable for creaming.

Too much moisture in cakes, as for example, those prepared by the “flour batter process,” will not only cause a shrinkage after baking but also a sinking of the fruit, if any, to the bottom, and so spoil the texture.

Too high temperatures prevent the proper “soaking” or baking of richly fruited cakes.

A too liberal use of powder, where used, makes the texture too light, and a sinking of the fruit and mixture takes place.

The mere opening of the oven door, or by disturbing the goods before the volume is fixed, will cause the tops of cakes to fall in and spoil them.

Cakes are usually judged from their general appearance, the flavour, and texture.

The general appearance includes the appearance of the crust, the evenness of the fruit distribution, the colour and brightness of the crumb and fruit, and the freedom from cracks on the surface, except in such cakes where breaks are desirable—*e.g.*, Madeira and others.

The flavour is largely due to the quality of the ingredients employed in making the cake. Only the very best ought to be used in high-class work.

The texture is formed mainly by the workmanship, type of flour used—a soft English wheat is the most suitable—quality and type of fat, the method of beating up so as to incorporate the maximum number of air globules being incorporated, care taken in mixing in the fruit and flour so as to secure the aeration. In fairly cheap cakes powder is an advantage.

The balancing of the ingredients in cake making is important, and by this is meant the proportions of the butter, sugar, eggs, flour, and fruit mixture.

Examples :—

Rich cakes, heavily fruited. Wedding cake type.

Butter.	Sugar.	Eggs.	Flour.	Mixed Fruit.
1	1	1	1	$4\frac{1}{2}$
1	1	$1\frac{1}{4}$	$1\frac{1}{8}$	5

Birthday cakes.

Butter.	Sugar.	Eggs.	Flour.	Mixed Fruit.
1	1	$1\frac{3}{4}$	$1\frac{1}{4}$	1
1	1	$1\frac{1}{2}$	$1\frac{1}{2}$	3
5	$5\frac{1}{2}$	6	9	7

Christmas cakes.

Butter.	Sugar.	Eggs.	Flour.	Mixed Fruit.
1	1	$1\frac{1}{2}$	$1\frac{1}{4}$	3
1	1	$1\frac{1}{4}$	$1\frac{1}{4}$	5
1	$\frac{3}{4}$	1	$1\frac{1}{4}$	4
1	1	$1\frac{1}{2}$	$1\frac{1}{2}$	4

A good quality slab cake.

Butter.	Sugar.	Eggs.	Flour.	Mixed Fruit.
1	1	$1\frac{1}{2}$	$1\frac{3}{4}$	$4\frac{1}{2}$

The slab is finished by bringing filleted almonds on the top.

A walnut gateau.

Butter.	Sugar.	Eggs.	Flour.	Chopped Walnuts.
1	2	7	7	3

The above examples should give some idea of the balancing of the materials. The figures represent parts by weight.

The process of making all the above would be : Cream together the butter and sugar, add the eggs gradually with thorough beating after each addition, then stir in the fruit and flour very lightly, making the whole into a clear fine batter. This is filled into paper hoops, sprinkled on the tops with chopped or filleted almonds, where required, and baked at 320° to 330° Fah.

Where almond paste is used it may be prepared from 7lbs. of ground almonds, 9lbs. of caster sugar, a wineglassful of rum, and about sixteen eggs, according to size.

Cheaper cakes than those specified may be made by increasing the sugar and flour, substituting for a portion of the butter with cheaper fats, decreasing the eggs and using milk and powder in their place.

Still cheaper cakes may be made by the "flour batter process." As a general rule these batters carry more liquor than sugar batters, but care should be taken not to render them too moist or the fruit will sink and the texture be spoiled.

Flour Batter Process of Harris and Borella.—The fats are beaten light and soft with an equal weight of flour, the eggs and sugar are beaten together like a sponge batter, but not quite so fully, as an egg batter lightly beaten does not blend so easily with the flour batter, and gives too firm a mixture. Blending should be done as lightly as possible, and must give a soft mellow emulsion.

The milk, if any, should next be added and mixed through, then the balance of the flour and when partly mixed the fruit, and the whole mixed lightly to a clear shining mass.

In very cheap cakes, where no eggs are used, the sugar, flavouring and colour are dissolved in the milk before blending with the flour batter, then as above.

Fermented Goods.—A considerable amount of care and patience is necessary in order to be successful in the making of fermented goods. The general process is as follows :—

Set a ferment in a mixing bowl at 95° Fah. with 8ozs. of strong flour, 12 to 15ozs. of milk, $\frac{3}{4}$ oz. of yeast, and 1oz. of sugar. Make the whole into a clear batter and place in a warm prover at 90° to 95° Fah. When ready, dough up with the proper constituents, say, 16ozs. of flour into which 4ozs. of fat has been rubbed, two or three eggs, and a trace of essence of lemon.

Work up into a clear dough and allow to ferment for about forty to fifty minutes. Scale off appropriately, mould, wash with egg or custard, prove, and bake.

The oven temperature should be from 440° to 480° Fah.

Aerated Goods.—Aerated goods must be very lightly and carefully handled so that success may be achieved in making these goods, otherwise small volumed and pinched-looking cakes will be the result. The powder should be very thoroughly sieved into the flour, which ought to be of the strong or medium strong variety.

Rice buns are a good example of aerated smalls :—

Weigh out 4lbs. of flour, 2ozs. of cream of tartar, 1oz. of bicarbonate of soda ; sieve these together at least four times ; 1½lbs. of caster sugar, 1¼lbs. of fat, ¾lb. of ground rice, 12 eggs, essence, egg colour and milk as required. Rub the fat into the flour and ground rice, make a ball and into this bring the sugar, eggs, essence and milk ; make up into a nice soft dough. Scale, mould, wash with egg, bring sugar on to the top of each cake, and after standing the requisite time to obtain the volume, bake at 450° Fah.

Sponges.—These goods include sponge moulds, Victoria sandwich, Swiss roll, small sponges, Savoy fingers, chocolate sponges, and many others.

Several methods of working are in vogue, each of which possess its own merits and disadvantages. For example, the London method, in which the whites of eggs are separated from the yolks and beaten up separately.

A mixing for three dozen twopenny sponges is as follows : 14 to 16ozs. of sugar, 14 to 16ozs. of medium flour, 10 to 12 eggs, and a minute quantity of “vol.” The most suitable baking temperatures vary between 420° and 460° Fah., according to the construction of the oven. Powder is often used in place of “vol” at the rate of ¼oz. to a pound of flour.

Dried eggs are unsatisfactory as they have a tendency to cause the goods to crack on the surface. Excess of powder also causes cracking and a shrivelled appearance. When

these goods are once placed in the oven do not open the door or touch the frames until the goods are cooked, as it may cause a sinking, small volume, and unsatisfactory goods. The best temperature for beating is between 75° and 85° Fah., hence it is advisable to warm the weighed quantity of sugar before adding it to the eggs.

The sponge frames require careful preparation or the cakes cannot be easily removed therefrom.

Paste Goods.—These include short paste, sweet paste, and puff paste goods.

GENERAL RECIPES FOR SHORT PASTE AND SHORT SWEET PASTE.

SHORT PASTE.

1lb. of soft flour, 8ozs. of butter or other fat, 1oz. of sugar, 1 egg or 2ozs. of broken eggs, with water as required to mix to a firm paste.

SHORT SWEET PASTE.

1lb. of soft flour, 10ozs. of butter or fat, 5ozs. of sugar, 1 egg or 2ozs. of broken egg. Make into a firm paste as above.

SCOTCH PUFF PASTE.

4lbs. of strong flour, 4lbs. of Siberian butter or half well-dried butter and half pastry margarine well blended together, $\frac{1}{2}$ oz. cream of tartar or lemon juice, about 1 quart of cold water.

Method: Sieve the cream of tartar and flour together; chop the fat into $\frac{1}{2}$ in. cubes, or simply chop the fat into the flour; add water gradually, and mix lightly into a firm paste. Give three double turns, and place on a cold slab between the turns.

ITALIAN PUFF PASTE.

Use either the above recipe or the following one: 3lbs. of strong flour, 3lbs. of suitable fat, $\frac{1}{4}$ oz. cream of tartar, 2 yolks, and about a litre (35ozs.) of cold water.

Method: Sieve the cream of tartar into the flour; then rub in the yolks and make a paste with the water of the same consistency as the fat; mould the latter into a flat cake

nearly as broad as the paste that should have been pinned out ; fold the paste around the fat and give a double turn. Two other double turns are necessary before working up the paste. There should be an interval of about half-an-hour between the two last double turns.

FRENCH PUFF PASTE.

The same two recipes given for Italian puff paste will do equally well for this process.

The chief point of difference between the Italian and French processes lies in the fact that in the latter from a quarter to one-third of the fat is rubbed into the flour, then as in the previous process.

SOME OF THE MORE COMMON FAULTS IN CAKES.

Flavour is mainly dependent on the use of good materials, especially the fats, and on correct methods of working throughout.

Dullness of crumb is frequently caused by a badly balanced recipe ; by careless workmanship ; by the use of low grade, dirty fruit ; by the use of cheap inferior sugar.

Sinking of fruit is brought about by a variety of causes, amongst which may be mentioned : Too wet and soft a mixture ; by too light a mixing ; by being disturbed in the oven before the mixture is set ; by the use of excess powder ; by using wet fruit. Often the use of a stronger flour will prevent the sinking.

Pie crust eats shorter if the fat (lard) is boiled with the water before mixing, or even by simple rubbing in.

Large and unsightly holes are due to : Too strong flour ; wrong baking temperatures ; a lack of steam will often cause cracks on the surface ; toughening a cake batter when mixing it ; by placing too few cakes in a large oven ; large holes near the crust by the use of too much steam.

Shrinking of Madeira cakes may be caused by the use of too much milk, or by making too stiff a batter.

Speckled teacakes are caused by over-fermentation and insufficient moisture in proving.

Crinkled skin on buns is often due to over-proving, especially in too much steam in the prover; or if proved in too dry a prover. They may be improved by baking in a hot oven.

Dryness of crumb may be brought about by the use of insufficient moisture; by an ill-balanced recipe; by the use of vol instead of powder.

Spotty tops by the use of too hard grained a sugar; or by making the batter too soft.

Crumbly cakes are caused by too light a mixture; the use of too much sugar or too much powder.

OVEN TEMPERATURES FOR CONFECTIONERS' GOODS.

The baking temperatures vary considerably with the many classes of goods; much, however, depends on the richness of the goods themselves, so that general principles only can be stated as a guide to beginners.

For the usual counter goods, including most varieties of yeast fermented goods, aerated or powder goods, puff paste goods (except for rich puff paste, where the oven may be 360° to 420° Fah.), short paste, smaller sponges, and Scotch shortbread, the oven temperatures may range between 450° and 500° Fah.

For small fancies of the frangipanni type, and such small cakes as golf, luncheon, Madeira, pound, tennis, etc., from 360° to 400° Fah.

For cakes of a richer character, as fruit cakes, cocoa-nut fancies, macaroons, and the like, from 330° to 360° Fah.

For all kinds of goods containing ginger, and still richer cakes than those in the paragraph above, a lower temperature is necessary, viz., 310° to 340° Fah., and for the best and heavily fruited cakes 290° to 320° Fah. will prove suitable baking temperatures.

Layer and slab cakes require temperatures in accordance with their richness, say from 320° to 400° Fah.

For the drying of meringues and cocoa-nut pyramids, such temperatures as will not decompose sugars, viz., from 230° to 250° Fah., are the best.

CHAPTER XIV.

THE ANALYSIS OF RAW MATERIALS.

IN a work of this scope it is only possible to give a very brief outline of the methods employed in testing and analysing confectioners' raw materials.

For the complete analysis of almost all of the materials already considered works devoted wholly to food analysis should be consulted. The names of several of the most useful will be found in the bibliography immediately before the index.

WATER TESTING.

For confectionery purposes water ought to be free from floating particles, sedimentary matter, and colour; it should not be too hard, and above all it must be organically pure.

Hardness is caused in a water by the presence of salts, like those of iron, calcium, and magnesium, that form insoluble soaps. The hardness may easily be noted by the amount of soap required to cause a permanent lather on the surface of the water, and by observing the presence or absence of a scum in water when soap is being used.

Organic impurities may be detected by the use of two special reagents—Nessler's solution and a permanganate of potash solution, both of which may be purchased at almost any chemist and druggist's. Nessler's solution, when added drop by drop to a water containing sewage or other organic impurity, gives a faint yellow to reddish-brown tint of colour. Pure water gives no colour with Nessler's reagent.

When permanganate solution is added to a water fit for drinking, better in the presence of a few drops of sulphuric acid previously added to the water, it should at once colour the water a permanent pink tint ; but if many drops of a weak solution of permanganate are required then the water is organically impure and unfit for domestic use.

MOISTURE DETERMINATION FOR ALL SUBSTANCES EXCEPT THE SUGARS.

The raw materials should be broken up into a moderately fine state of division. For example, it is very often advisable to find out how much water is contained in samples of coke. First collect pieces of coke from all parts of the load ; crush up roughly in a mortar, then more finely until all the particles are about the size of a pea. Bring one pound of this into a weighed shallow sandwich tin, spread evenly all over the bottom of the tin, place in an oven where the temperature is suitable for drying off meringues, and allow to remain about three hours. Take out from the oven and cool under a cover in a dry place, then weigh. The loss in weight is due to the water driven out of the coke.

Example :

The weight of the sandwich tin is 12.5 ozs.

The weight of the tin and coke before drying = 28.5 ozs.

The weight of the tin and coke after drying = 25.5 ozs.

	Loss 3.0 ozs.
	3.0 ozs.

Then $28.5 - 12.5 = 16.0$ ozs. of coke taken.

$25.5 - 12.5 = 13.0$ ozs. of dried coke.

It will be seen that 16.0 ozs. of coke lose 3 ozs. on drying.

Therefore $\frac{3 \times 100}{16} = 18.75$, the loss on 100 parts of coke.

This means that one cwt. (112lbs.) contains :

$$\frac{18.75 \times 112}{100} = \frac{2100}{100} = 21 \text{ lbs. of water.}$$

The moisture in flour, or in a meal, or in starch. Clean and accurately weigh a squat, wide weighing glass (Fig. 33). Bring into it some of the flour, remove any particles from the outside of the glass, place on the lid and weigh. Bring the glass and flour into a water-oven or air-bath at a temperature 212° — 214° Fah., remove the lid and allow to remain for four hours. Remove into a desiccator (Fig. 34) to cool, place on the lid, and weigh. Repeat the heating, desiccating and weighing until the weight is constant. Always weigh with the lid on so as to prevent the dried flour or other substance from re-absorbing water during the weighings.

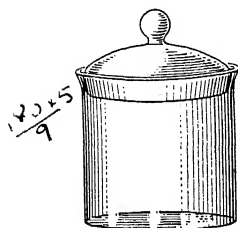


FIG. 33.
Weighing Glass.

Example :

The weight of the glass and lid = 14.75 grams.

The weight of glass and flour before drying = 25.75 grams.

The weight of glass = 14.75 „

Flour taken = 11.00

The weight of glass and flour after drying = 24.25 „

The loss is $25.75 - 24.25 = 1.5$ grams.

Therefore $\frac{1.5 \times 100}{11} = 13.64$ per cent. of water in the flour.

Occasionally one hears of starch, flours, meals, and cereal products being dried at temperatures approaching 220° Fah. This is too high, as decomposition occurs in these substances and thus causes error.

A desiccator (Fig. 34) is a glass vessel containing granular calcium chloride, this latter acting as a moisture absorbing agent, so that cooling of the flour or other substance may take place in the absence of moisture.

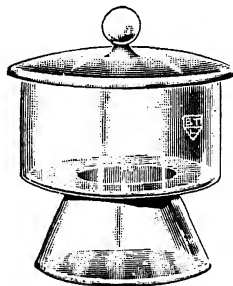


FIG. 34.
Desiccator.

THE ESTIMATION OF MINERAL MATTER OR ASH.

A platinum capsule is cleaned and accurately weighed. Five or more grams of the flour, fruit, or other substance are brought into the capsule and the whole weighed. The capsule is now placed on a clay triangle fixed on an iron tripod and gently heated with a bunsen burner until the contents are reduced to the state of carbon (black). The heating is further continued until nothing but a white to greyish-coloured ash remains in the capsule. Cool in a desiccator and weigh. Repeat the heating, desiccating and weighing until constant.

Example :

The weight of the platinum capsule = 16.50 grams.

The capsule and flour before burning = 24.32 grams.

The capsule = 16.50 "

Flour taken = 7.82 "

The capsule and ash after incineration = 16.57 grams.

The weight of the ash is $16.57 - 16.50 = 0.07$ gram.

Therefore $\frac{0.07 \times 100}{7.82} = 0.895$ per cent. of ash in the flour.

Silica and Phosphates.—The ash obtained in the previous determination is digested with concentrated hydrochloric acid (HCl), boiled to dryness on a water-bath, taken up with dilute HCl, again boiled to dryness, taken up with a few drops of weak nitric acid, the silica (SiO₂) filtered off and thoroughly washed with boiling water. The silica is dried, ignited into a weighed porcelain crucible, desiccated and weighed as SiO₂. Repeat the heating, desiccation, and weighing until weight is constant.

The filtrate and washings contain the whole of the phosphates. Add ammonia and magnesia mixture (equal volumes of 10 per cent. solutions of magnesium chloride or sulphate and ammonium chloride to which is added an equal volume of strong ammonia solution (0.880)). Cover the beaker and allow to stand in a cool place for at least twelve hours. Filter through a Swedish filter paper, wash with cold dilute ammonia, dry, ignite, gently at first, then more strongly, desiccate and

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weigh. Repeat until the residue is constant in weight. From the amount of pyrophosphate of magnesium ($\text{Mg}_2\text{P}_2\text{O}_7$), calculate the phosphate to the anhydride (P_2O_5) and express as a percentage on the weight of the ash.

The Nitrogenous Bodies.—Where the estimation is to be carried out with solids, the weighed quantity of dried solid is introduced into the special long-necked, hard glass flask together with a globule of mercury, two grains of mercury oxide, five grams of fused bisulphate of potash (KHSO_4) or phosphoric anhydride (P_2O_5) and ten c.c. of Kjeldahl acid.

A small piece of paraffin wax is dropped into the flask to prevent frothing. The flask and contents are strongly heated on a sand-bath, placed in a fume cupboard, until clear and colourless. The clear liquid is diluted with water and transferred to the distilling flask of an ammonia apparatus. This is connected together, strong caustic soda run into the acid liquid and the ammonia distilled over into a known volume of standard acid; the excess acidity is titrated with standard alkali and the ammonia calculated to nitrogen.

Nitrogen $\times 6.3$ = proteins.

The quantities taken for estimation vary from five to ten c.c. of a solution containing nitrogenous matter, and from one to ten grams of dry solid according to the quantity of nitrogenous matter present.

The Sugars.

The sugars employed in the confectionery industry include the various forms of sucroses—chiefly mixtures of cane and beet sugars—and glucoses, especially the colourless, viscid syrup or bleached glucose syrup. For a confectioner's general analysis of sugars see page 75. The chemical analysis includes the estimation of the total solids; the moisture; the amount of actual sugars present, which involves the determination of the copper reducing or K value, and the opticity or the S.R.P.; the nitrogenous matter; the acidity; the detection of iron salts; and the mineral matter or ash.

A 10 per cent. solution is prepared by weighing ten grams of the sample of sugar in a small lipped beaker, dissolving in

hot water, transferring, with the proper precautions, to a 100 c.c. graduated flask, cooling and making up to the mark at 60° Fah. The contents of the flask are then thoroughly shaken so as to mix them.

The Total Solids and Moisture.—A fifty c.c. specific gravity bottle is cleaned, dried, and weighed. It is then filled completely with distilled water at 60°, the stopper forced home, the outside carefully dried, and weighed. The water is poured out and the inside of the bottle rinsed with some of the 10 per cent. sugar solution, completely emptied, then filled to the top with the sugar solution, the stopper placed in position, the outside of the bottle carefully cleaned, and then weighed.

Calculation :—

Let A equal the weight of the clean, dry, empty bottle.

Let B equal the weight of the bottle and water.

Let C equal the weight of the bottle and sugar solution.

Then B—A=the weight of water contained in the bottle.

Then C—A=the weight of sugar solution contained in the bottle.

The specific gravity will be $\frac{C-A}{B-A}$

An example will make this clear.

$$\frac{C-A}{B-A} = \frac{76.68-24.79}{74.77-24.79} = \frac{51.89}{49.98} = 1038.21 \text{ where water}=1000.$$

In order to obtain the total solids deduct 1000 from the specific gravity and divide the remainder by 3.86, thus

$$1038.21-1000=38.21. \quad \frac{38.21}{3.86}=9.898, \text{ these are the solids}$$

in ten grams of the sugar.

Deduct this number from 10 and obtain the moisture.

10.000—9.898=0.102, the amount of water in the sample.

Multiply by 10 so as to get the parts per 100 or the percentage.

9.898×10=98.98 per cent of solids in the sugar.

0.102×10= 1.02 per cent. of water.

The factor 3.86 is obtained, practically, by dissolving one gram of alcohol purified sugar in water and making up to 100 c.c. at 60° Fah. (Note: not 100 c.c. of water.) Shake the flask well. Then determine the specific gravity; this equals 1003.86 for the 1 per cent. of pure sugar; if ten grams are dissolved in pure water and made up to 100 c.c. the specific gravity will be 1038.6; hence, the solids factor is 3.86 for sugars.

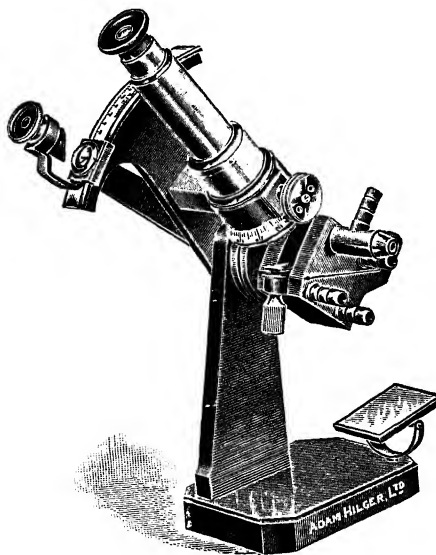


FIG. 35.—Abbé Refractometer.

In modern sugar works and large sugar boiling factories the total solids are determined by means of an Abbé Refractometer (Fig. 35) fitted with a solids or sugar scale. All that is necessary is to cover the moveable prism of the instrument with two or three drops of the 10 per cent. sugar solution, spread evenly over the surface, close the instrument, adjust the light, and take the reading. The time occupied

is about two minutes. The same refractometer may be used for determining the purity or otherwise of essential oils, butters, and other fats.

The only disadvantage of this method is the very high cost of the instrument itself.

The Sugar Estimation—The Opticity.—A two decimetre tube is completely filled with some of the 10 per cent. solution, the tube placed in position in a Laurent or Schmidt-Haensch polarimeter, and the reading taken; from this the specific rotatory power (S.R.P.) is calculated, and from the result the percentage of sugar in the sample may be obtained. For the Laurent instrument (Fig. 36) with which a sodium flame is used so that light all of one colour is secured, the simplest form of calculation is as under:

The opticity is based on a 10 per cent. of sugar solution read off in a tube a metre long (1 metre=39·138 ins.), and the reading in this case is taken in a two decimetre tube, *i.e.*, a fifth of a metre; multiply the reading by five, then calculate the percentage of sugar, remembering that for a 100 per cent. sugar the S.R.P. is 66·5.

The reading is 13·16 degrees, and $13·16 \times 5 = 65·80$, the opticity of the given solution.

The percentage of sugar will be $\frac{65·80}{66·5} = 98·94$.

It will be remembered that this sample of sugar gave 98·98 per cent. of total solids, of which 98·94 is sugar. The other 0·04 parts probably consist of nitrogenous matter and mineral salts. A sugar so pure is unlikely to contain either acidity, iron salts, or blue compounds.

The analytical results may be summarised as:—

Sugar or sucrose	98·94
Moisture	1·02
Traces of other bodies	0·04
	<hr/>
	100·00

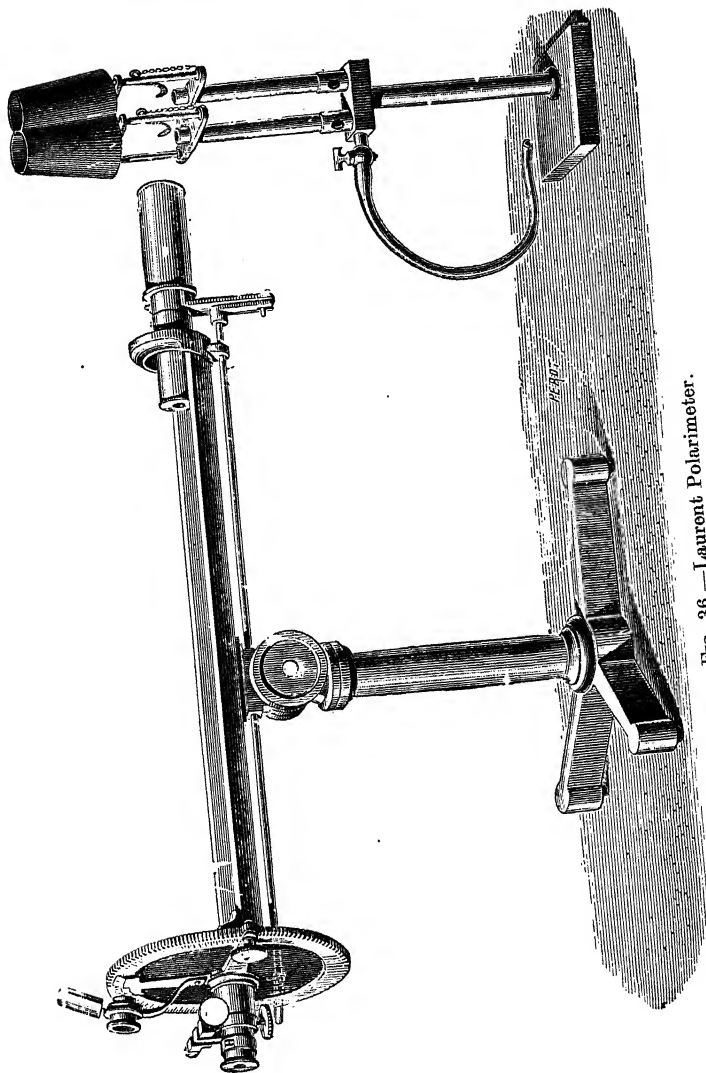


FIG. 36.—Laurent Polarimeter.

The copper reducing value of so pure a sugar will be a mere trace. For a less pure sucrose, say one containing some invert sugar, the process will be :—

Bring 50 c.c. of Fehling's solution (alkaline copper tartrate) into a white glazed porcelain beaker, add 40 c.c. of distilled water, place in a water-bath, cover the beaker with a clock glass to keep out dust, and bring to the boil. This takes about twenty minutes. By means of a pipette run 10 c.c. of the 10 per cent. sugar solution into the hot Fehling's solution, cover as before, and boil for ten minutes. Take the beaker out of the water-bath, allow the precipitated red copper oxide (Cu_2O) to settle for a few minutes; filter off through a Swedish filter paper; wash out the beaker very thoroughly; wash all the blue copper salt out of the filter paper, cover, dry, ignite into a weighed porcelain crucible, desiccate and weigh as black copper oxide (CuO). The weight of $\text{CuO} \times 0.4715 =$ invert sugar from the 10 c.c. of the 10 per cent. impure sugar solution, *i.e.*, it is the invert sugar contained in one gram of sucrose. Multiply by 100 and obtain the percentage of invert sugar in the sample.

The following factors will be found useful in sugar analysis :

$$\text{CuO} \times 0.7435 = \text{maltose.}$$

$$\text{CuO} \times 0.4535 = \text{dextrose.}$$

$$\text{CuO} \times 0.4715 = \text{invert sugar.}$$

$$\text{CuO} \times 0.4715 \times \frac{19}{20} = \text{sucrose.}$$

The K values for sugars are :—

$$K, \text{ for dextrose} = 100.$$

$$K, \text{ for laevulose} = 92.4.$$

$$K, \text{ for maltose} = 61.07.$$

$$K, \text{ for invert sugar} = 96.6.$$

One gram of pure dextrose yields 2.578 grams of CuO .

The Acidity. Whatever may be the cause of acidity in sugar it is always calculated as lactic acid, $\text{CH}_3\cdot\text{CH}(\text{OH})\cdot\text{COOH}$, which has a molecular weight 90. The sugar solution is filtered bright, 25 c.c. are brought into a small sized flask, a few drops of methyl orange added as an indicator to show the

end of the reaction, and then titrated with a deci- or centi-normal caustic soda solution, 1 c.c. of which contains either 0.004 or 0.0004 of NaOH, and equals either 0.009 or 0.0009 of lactic acid, according as deci- or centi-normal NaOH is used. Two or preferably three titrations should be carried out, and the mean of the last two taken as the result.

Pure sugar should not be acid, but many of the low grade sugars contain an appreciable amount, and this helps to spoil the flavour of the goods.

Acidity in a sugar solution or syrup may easily be detected by the use of litmus papers. Blue litmus paper becomes red when dipped into an acid liquid, whilst red litmus paper becomes blue if brought into an alkaline solution like soda.

The Mineral Matter or Ash.—This determination is carried out exactly as stated in the estimation of the ash in substances generally.

THE FATS.

The examination of fats is far too complex a problem for all except highly trained chemists. It is proposed therefore to insert in this chapter a few simple tests that may prove useful to those in the trade. These consist in the determination of the specific gravity, the moisture, the melting and solidifying points, the appearance of any brine that can be beaten out from the fat, the aroma, and taste.

Physical determinations additional—the Maumené thermal test; the bromine thermal test; the Valenta test based on the difference in solubility in acetic acid; and the refractive index or power of the fat. The viscosity of food fats is of no practical importance.

Chemical determinations.—These include the acid value which indicates the amount of free fatty acids present in the sample; the saponification equivalent or value; the Hehner value; the Reichert-Meissl figure; the Polenske value; the iodine and bromine values; the acetyl value and a number of other estimations; also the detection of colouring matter and preservatives.

The **specific gravity** of oils and fats, including the volatile essential oils, may best be determined by means of a Sprengel apparatus (Fig. 37), a method very similar to that employed for the gravity of sugar and other solutions. The Sprengel tube is constructed of glass, or better, of fused silica ware.

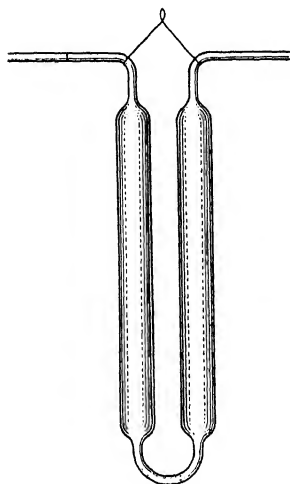


FIG. 37. Sprengel Specific Gravity Tube for fats.

First find the weight of the clean, dry apparatus; the weight of water may always be taken as ten grams: then fill to the marks with the melted fat or oil, clean and weigh accurately. The specific gravity = $\frac{\text{weight of fat or oil.}}{\text{weight of water.}}$ This

method is much more accurate than that in which special hydrometers are employed for the purpose.

The Melting Point.—Fine capillary tubes, open at both ends, are required. Several of these are dipped into the melted fat, allowed to stand for twelve hours, then the outside is carefully cleaned, one of the tubes at a time is attached to the

stem of a thermometer slightly above the bulb with a thin rubber band, then placed in a beaker containing water, and the latter gently heated with continuous stirring until the fat melts and rises in the tube. The temperature on the thermometer is read off: this is the melting point of the fat. Determine each of the other tubes separately and take the mean of all the readings—melting point.

The Solidification Point or Titre Test.—Several small glass tubes, containing the fat and fitted with a thermometer for stirring and taking temperatures, are placed in a larger tube and the fats are melted, then very gradually cooled. When the solidifying begins stir the fats several times to the left

and the same number of times to the right. The mercury column of each thermometer first falls, then suddenly rises, and remains constant for two or three minutes. This temperature is the solidifying point of the fat. As before, take the mean of all the readings for the actual result.

The Brine Test.—Quite a number of the fats used in the trade contain both salt and water, as for example butters and margarines. The salt is often in the crystalline condition, therefore the fat should be washed carefully with a small quantity of water to dissolve the salt; then beat out this brine and collect in a clear glass, hold up before a good light, and note the appearance of the brine. If it is clear and devoid of turbidity no decomposition has taken place in the fat; on the other hand if it is opalescent and dull-looking the fat has begun to decompose. Such fats ought not to be employed by confectioners.

The aroma or smell and flavour of all edible fats should be pleasant.

Points of Difference between Butters and Margarines, practical tests.

- (1) The fracture, smell, and general appearance.
- (2) Bring a small lump of the fat into an iron spoon and warm gently. Note carefully the way in which the fat boils. If gently, with the curd spreading over the surface, the fat is probably butter; if it boils with bumping and the curd collected into a lump the fat is possibly margarine.
- (3) Note the smell of the boiling fat after withdrawing from the source of heat. Butter has the characteristic smell of butyric, or real butter smell. Margarine possesses a tallowy aroma.

Estimation of Amount of Fat.

The Fats.—Fats in food-stuffs exist either as glycerides, or as phosphorised fats, generally glycerophosphates or lecithines. These latter bodies occur in the germ or nucleus of plants and in the yolk in animal life.

The dry ether extraction process is probably the most accurate method of estimation. In the case of liquids the sp. gr. must be ascertained, then a known volume—5 or 10 c.c.—is used for spotting the inside of a Schleicher and Schüll fat-free extraction thimble; this is air-dried and brought into a Soxhlet extraction apparatus in which the fat is extracted by repeated washings with dry ether (Fig. 38).

The ether is distilled off and the residue brought into a small weighed beaker together with the ether washings of the flask. The ether is allowed to evaporate by placing the beaker on to the top of an air-bath, the last traces being expelled by an air blast, then desiccated and weighed.

To extract the fat from solids, a given weight—five or ten or more grams—of the dry solid are brought into the fat-free thimble and treated as described above. With finely divided substances like flour it is better to use a double thimble of large size.

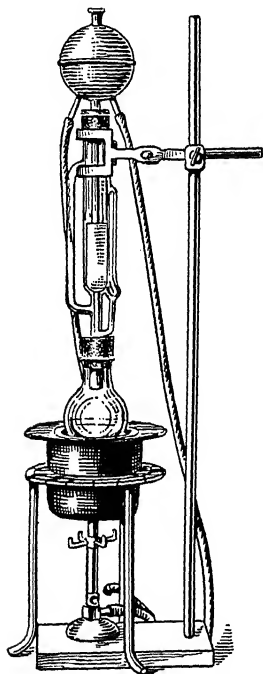


FIG. 38.--Soxhlet Fat Extractor.

ESSENTIAL OILS.

The simple analysis includes the determination of the specific gravity by means of a Sprengel tube; the refractive index by the Abbé or some other suitable refractometer; the opticity by the use of a Laurent polarimeter, or

by the Lippich instrument, which is more delicate and gives results of greater accuracy in its readings; and the residue when evaporated to dryness on a water

ESSENCES.

The only determinations that can be undertaken by an amateur are those of the boiling point, the specific gravity, and the quantity of residue when a known volume is evaporated to dryness on a water-bath.

STARCHES.

The presence of foreign starches in any uncooked material may be detected by the aid of a good compound microscope, a matter that requires considerable practice, and then only under the supervision of an expert microscopist.

THE ACIDITY.

The amount of acidity in any of the raw materials such as cream of tartar, lactic acid, etc., may be determined as follows :

If the substance is a solid weigh out from five to ten grams, dissolve in water, and make up to a hundred c.c. at 60° Fah. in a graduated flask. Place in the stopper, and shake thoroughly. Measure out either 10 or 25 c.c. by a pipette into a small conical flask, dilute with distilled water, add a few drops of either litmus or methyl-orange solution as an indicator, and titrate from a burette with standard caustic soda solution, of which the value of each c.c. is known. When the acidity is neutralised by the soda, read off the quantity used ; repeat the titration once or twice more, take the mean of the last two readings and calculate to the appropriate acid ; if a food substance to lactic acid. *Example* : 25 c.c. of a 10 per cent. solution of extract from a food substance requires on the average 5 c.c. of a deci-normal ($\frac{N}{10}$), solution of caustic soda, NaOH, 1 c.c. of which contains 0.004 of soda and is equal to 0.009 of lactic acid.

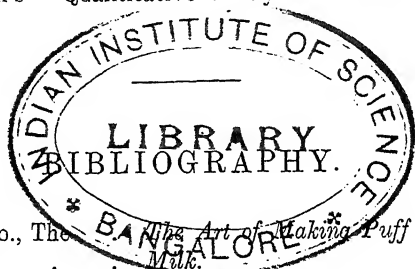
Then $0.009 \times 5 = 0.045$, of lactic acid contained in 25 c.c. of the food solution.

100 c.c. will contain $\frac{0.045 \times 100}{25} = 0.180$ of lactic in ten grams of the substance.

Therefore in a 100 grams there will be

$$\frac{0.180 \times 100}{10} = 1.80 \text{ per cent. of acidity.}$$

For further information on this subject some standard book like that of Sutton's "Volumetric Analysis," or Clowes and Coleman's "Quantitative Analysis" should be consulted.



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